

SCIENCE

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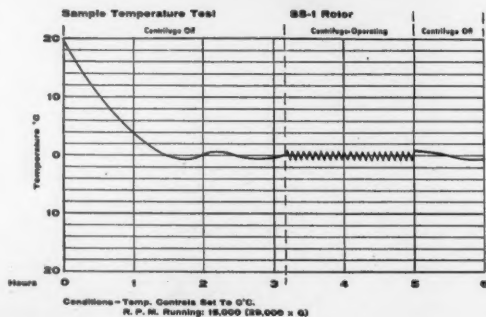
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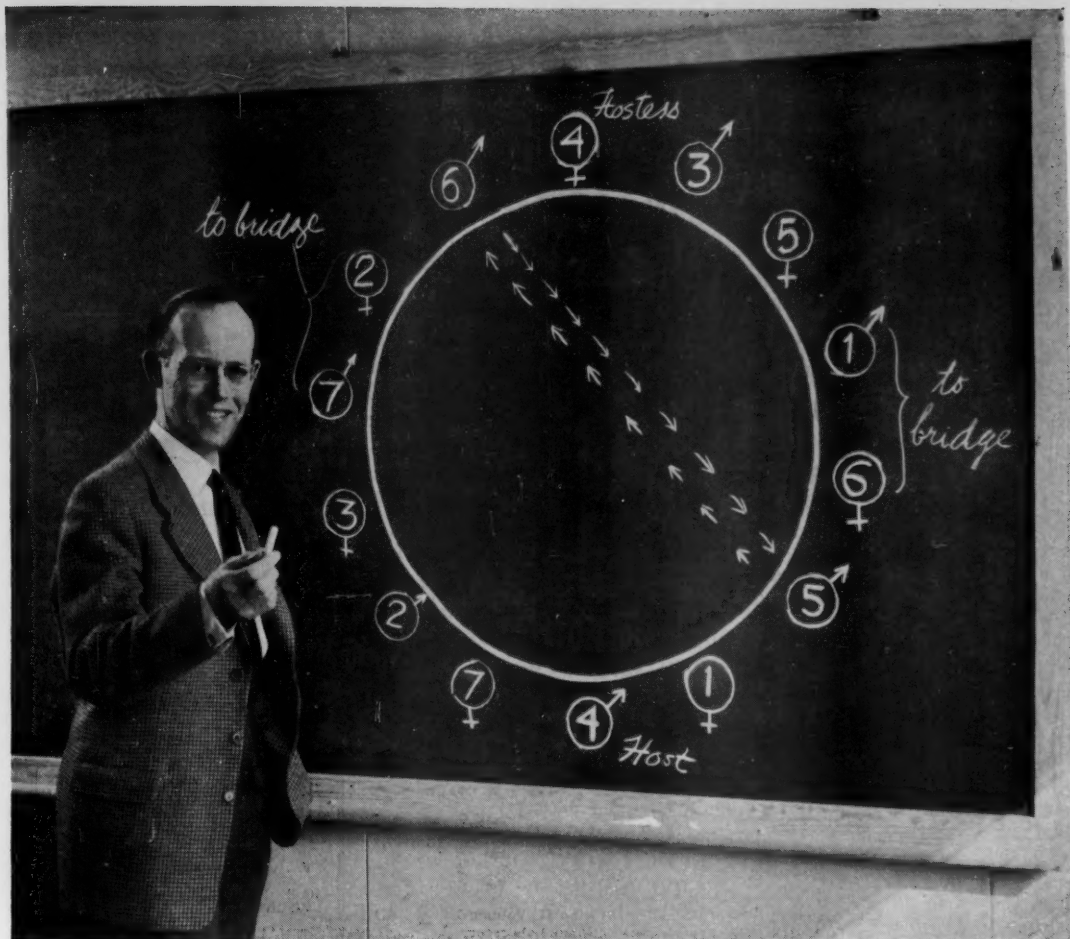


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Defense Science Board

One problem that faces the incoming Assistant Secretary of Defense for Research and Engineering is how best to exploit and advance the state of science as it bears on the defense of the nation. To advise him, a 25-member Defense Science Board was established toward the close of last year by Clifford C. Furnas, who was then Assistant Secretary for Research and Development. (This office and the Assistant Secretary for Engineering were joined recently to form the one office of Assistant Secretary for Research and Engineering, see *Science* editorial of 10 May 1957, page 913.) The use of committees to help make decisions is familiar practice in the Pentagon, but the Defense Science Board does raise some questions of scope and membership.

Inspiration for the board derives in part from the 1955 Hoover Commission report on research and development in the Government. In a broad statement to which there may be important exceptions, the report refers to the "conservative approach of a military organization, even when possessed of adequate technical competence," and calls for "radically new approaches to weapons systems." Specifically, the report recommends that the assistant secretary set up a committee of "outstanding basic and applied scientists" and that, on the basis of the committee's recommendations, he initiate studies for new weapons from funds to be placed at his disposal. Such studies would be within the framework of the Department of Defense, supplementing the research and development programs that are planned and executed in the three military departments.

The charter of the Defense Science Board gives the board this advisory task and, in addition, assigns a second area of duties. The board is to suggest changes in departmental organization, should it find that administrative procedures are less effective than they might be. However, what in practice the board will do remains to be seen, especially since the assistant secretary who signed the charter is not the one whom the board will advise. Although no new funds have as yet been set aside for the purpose, the board may suggest special studies to be initiated by the assistant secretary, or it may seek, by organizational changes, to produce a climate in the military departments more favorable to "radically new approaches." To date, the board is known principally for its opposition to Frank D. Newbury, whose resignation as Assistant Secretary for Research and Engineering was recently accepted and who, so the board charged, neglected the development of new weapons.

With both administrative and substantive questions of science in its domain, the board faces a larger order of business—or possibly a different order—than that recommended by the Hoover Commission's report. Judging from its membership, the board seems to be in a better position to advise on questions of organization than to offer firsthand opinions on new scientific and technologic ideas. Of its 25 members, 18 serve by virtue of their positions as chairmen of various scientific and technical panels in the Pentagon or as heads of defense related agencies. Of the seven members-at-large, five are still to be appointed. The Hoover report, incidentally, mentions only three *ex officio* members.

Finding members for a senior committee poses something of a problem. Chances are that a scientist who is sufficiently well known to command respect outside his circle of fellow-specialists will be doing administrative work rather than research. If the Defense Science Board is to advise on substantive, as well as administrative, questions, then much depends on the appointments yet to be made—to be made, moreover, by a new assistant secretary, who is himself yet to be named.—J. T.



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Safety Testing of Poliomyelitis Vaccine

Paul Meier

Much interest and, indeed, concern have lately been expressed about public lack of confidence in science and scientists (1). Although such attitudes stem from a variety of causes, many of which are beyond the control of the scientific community, it is important that legitimate grounds for distrust be eliminated. Several observers (2-8) have expressed doubts about the propriety of important decisions made in the poliomyelitis vaccine program. Certainly, if these doubts are valid, steps should be taken to prevent the occurrence of similar situations in the future.

When the Salk poliomyelitis vaccine was released for widespread use in April 1955, and despite assurances of safety, a number of vaccinated children developed poliomyelitis. Since most of these cases were associated with lots of vaccine produced by the Cutter Laboratories, this event has come to be known as the Cutter incident. Much has been written about the causes of the Cutter incident and the precautions taken to prevent a recurrence. However, several important questions have not been satisfactorily answered. Why were the intensive scientific preparations inadequate to prevent the distribution of infectious vaccine? And why was the early evidence of unreliability in the inactivation process not publicly acknowledged until after the Cutter incident?

This article reviews some aspects of the poliomyelitis vaccine safety testing program which seem to have important implications for scientists generally. It is based on a study of publicly available documents and papers, as indicated in

the references. The most informative sources were the United States Public Health Service "White Paper" (9) and the record of testimony before the House of Representatives Committee on Interstate and Foreign Commerce (10).

General Review

The Salk vaccine is prepared by treating live poliomyelitis virus with a killing agent, formaldehyde, which destroys the ability of the virus to infect a human cell while preserving its ability to produce protective antibodies—that is, its antigenicity (11). In fact, prolonged treatment with formaldehyde will destroy the antigenic property as well, thereby making the vaccine safe, but worthless. The production of a useful vaccine, then, creates a delicate problem in safety—the vaccine must be treated sufficiently to destroy infectivity but not so much as to destroy or seriously impair antigenicity.

Inactivated virus vaccines against poliomyelitis were first used in this country in the early 1930's. The Kolmer vaccine was known to contain a small amount of live virus capable of infecting monkeys, but it was presumed to be safe for humans on the basis of the unproved assumption that serial passage in monkeys had reduced its pathogenicity for man. This vaccine was clearly implicated as the cause of a number of cases of poliomyelitis. The Brodie vaccine, believed to be completely inactivated, was also suspected of causing several cases of poliomyelitis, but the evidence is much less convincing. At a meeting of the American Public Health Association in November 1935, reports were given on both vaccines. During the discussion of these reports, both vaccines were roundly con-

demned, particularly by Rivers of the Rockefeller Foundation and by Leake of the U.S. Public Health Service (12). Shortly thereafter, Leake published a list of vaccine-associated cases (13), and the vaccines were withdrawn from use.

The development of tissue-culture techniques by Enders, Weller, and Robbins (14) made it possible to grow virus easily and to obtain an index of its infectivity, thus opening the way to a fresh attack on the vaccine problem. About 1953, Salk developed a process which he believed capable of producing a safe and effective inactivated virus vaccine.

In view of the 1935 experience, the question of safety was a primary issue, and in May 1954, just after the start of the large-scale field trial (15), Salk published an account of the theory of the inactivation process which, he believed, guaranteed "absolute safety" of the final product (16). To Salk, the theoretical argument was so convincing that he argued against the employment of expensive and difficult procedures which had been suggested for the detection of possible residual live virus in the final product (16, p. 568). The theory itself is quite simple. The inactivation was believed to be a first-order chemical reaction and, consequently, the proportion of original virus still infective at time t should be e^{-kt} , where k is the rate constant for the reaction. If the number of infective virus particles at time zero and the rate constant are known, one can specify a time at which the probability of there remaining any infective particles is vanishingly small and, for practical purposes, the product could be guaranteed to be free of infective virus. If with this much treatment the material is still highly antigenic, the process can be made to yield a safe, potent vaccine.

Unfortunately, Salk's 1954 paper did not give detailed evidence in support of this theory, and the state of knowledge at the time, as judged from other sources, makes the validity of these assumptions appear questionable. The virus suspension from which the vaccine is made is a heterogeneous mixture, containing, for example, considerably more monkey kidney protein than poliomyelitis virus. Even if the rate of inactivation appeared constant over the observable range, the extrapolation beyond the observations would be questionable. Actually, some of the data presented by

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Salk in February 1955 (17) show a non-constant rate of inactivation. Inactivation data for the Mahoney strain are shown for lots produced by manufacturers A and B. In each of the nine lots produced by manufacturer A, a decrease in the observed inactivation rate becomes apparent at 72 hours. The change in rate is not evident on the summary graph (17, Fig. 5) because the final 72-hour average is omitted. There is no evidence of a systematic change with time in the rates for the nine lots produced by manufacturer B, although it should be noted that the inactivation rates are not determined with very high precision. A recent paper (18), reporting the experience of one of the vaccine manufacturers, points out that the inactivation rate undergoes a marked change within the first few hours and, therefore, that first-order kinetics cannot safely be used to extrapolate the inactivation curve. A more detailed analysis of the kinetics of virus inactivation in the preparation of poliomyelitis vaccine is given by Gard (19).

Salk's application of his theory also depended on the unstated assumption that a single live virus particle will invariably be detected if tested in a tissue-culture preparation. However, tissue-culture preparations were known to vary widely in sensitivity from batch to batch, and there was some evidence that tissues other than monkey kidney were, on the average, more sensitive (20). There was, furthermore, no evidence on the relative sensitivity of children and tissue-culture preparations. To be on the safe side, one had to suppose that a single virus particle might infect a child, so that it was important to estimate the sensitivity of monkey kidney tissue culture in absolute terms. On the basis of electron microscope measurements (21), Schwerdt and Schaeffer estimated the chance of infecting a tissue-culture preparation with a single virus particle to be of the order of 0.005, or 1 in 200. This figure is surprisingly low, and there was room for some doubt about its validity (22). However, this seems to have been the only experimentally based estimate of the absolute magnitude of tissue-culture sensitivity available in 1954. More refined measurements, reported after the Cutter incident, raise this figure to about 0.02, or 1 in 50 (23).

In preparation for the field trial of 1954 (15), six drug manufacturers began to produce poliomyelitis vaccine. Their findings made such considerations largely academic. Although they believed that they were following Salk's procedure, residual live virus was found in a number of lots of vaccine from each manufacturer. Thus, whatever the merits of the theory for vaccine made by Salk himself, it clearly could not be applied to the production process used by the

manufacturers. At this time, all lots of vaccine were being tested by three laboratories independently—that is, by the manufacturer, by Salk, and by the Public Health Service. In many cases, the presence of live virus was detected by one laboratory, but not by the other two, suggesting the possibility of considerable variability in the sensitivity of the test (9).

In April 1954, the Vaccine Advisory Committee of the National Foundation for Infantile Paralysis met with a group of experts from the Public Health Service to decide whether or not to proceed with the scheduled field trial. At this point, only 16 manufactured lots had been tested, and, although four of them had been shown to contain infective virus, the last ten had tested negative. Furthermore, no poliomyelitis had been detected among a group of several thousand children inoculated with vaccine from commercial lots which had passed the tests. The committee decided to proceed with the field trial, using vaccine produced by the two largest manufacturers. No public acknowledgment of the manufacturing difficulties was made at this time, but the Vaccine Advisory Committee released a public statement which was concurred in by the Public Health Service, and which, in effect, gave assurances that the vaccine was safe.

In anticipation of a successful field trial, additional lots of vaccine were produced by all the manufacturers, and residual live virus was again found in occasional lots. Testing in three laboratories was no longer required, and manufacturers varied in the amount of vaccine that they tested (24). The Public Health Service Minimum Requirements (25) specified only that 0.1 percent of each lot should be tested in tissue culture, but most of the manufacturers tested considerably greater volumes. Tests in monkeys were also required and performed.

On 12 April 1955, the results of the field trial were made public. The findings were interpreted as convincing evidence of the safety of the vaccine as well as proof of its effectiveness. The six manufacturers were immediately licensed, and all but one of them began to distribute poliomyelitis vaccine. However, the vaccines used in the field trial, which were produced by two of the manufacturers, had been extensively tested in three laboratories and had been found negative for live virus. Many of the lots of vaccine released after the field trial had been produced by other manufacturers and had been tested only by the producer. Therefore, the safety of these lots could not properly be judged from the results of the field trial. All manufacturers had rejected some lots because live virus had been found in them, and

therefore Salk's theory that safety was guaranteed by the method of preparation obviously did not apply. The final tissue-culture and monkey tests were the only safeguards provided against the release of lots containing live virus, and the sensitivity of these tests was not known. Within a week or two of the mass distribution of vaccine, it became evident that the experience of 1935 had been repeated—a number of cases of poliomyelitis were clearly associated with the administration of certain lots of vaccine—and within the next few weeks all poliomyelitis vaccine was withdrawn. In subsequent weeks, production processes and safety test procedures were revised, and vaccine distribution was gradually resumed.

Modifications of the Program

When, on 12 April 1955, the Salk vaccine became a licensed product, the Public Health Service became responsible for the establishment of minimum requirements for its potency and safety. Such requirements had been established before 12 April so that the licensing of the vaccine would not be delayed if the field trial proved successful. However, when the Cutter incident was recognized, the advice of a number of experts was sought, and on 26 May 1955, the Technical Committee on Poliomyelitis Vaccine was formed as a permanent advisory group. The committee was to advise the Public Health Service on the release of individual lots of vaccine and to give continuing guidance on vaccine production and testing.

In June 1955, the Public Health Service released the White Paper, a technical report on the Salk vaccine (9). The White Paper reviewed the entire experience with vaccine production and thus made public the fact that live virus had been found in lots of vaccine produced by each of the manufacturers. The White Paper also presented an analysis of the safety test procedure, with recommendations for a considerably more stringent testing program.

The analysis of the test procedure rested on two basic assumptions. First, the live virus was supposed to be present in particulates (single virus particles or, possibly, aggregates of virus particles) which were randomly distributed throughout the lot of vaccine. Second, it was assumed that if such a particle were included in the test sample its presence would be detected with certainty. From these assumptions, it follows that if a lot contains r such infective particulates per liter and v liters are tested, the probability of detecting the presence of live virus is given by $(1 - e^{-rv})$. A test of only 0.1 percent of, say, a 40-liter lot might easily fail to detect infectivity at the level

of 10 particulates per liter, since the probability of detecting infectivity in such a case is only 0.33, or one chance in three. The White Paper recommended that 1.5 liters be tested from each of the three single-strain vaccines and that 1.5 liters be tested from the mixed final vaccine, regardless of the lot size. According to this theory, each of these tests should independently have a probability better than 0.999 of detecting the presence of live virus at the level of 5 particulates per liter.

It has been pointed out that the ability to reject defective lots with high probability does not guarantee that all infective lots in a long sequence are rejected. However, if the frequency with which lots are rejected is found to be low, it can be shown that the average infectivity of the lots accepted will also be quite low (26).

The choice of 5 particulates per liter is arbitrary. In view of the low annual incidence of paralytic poliomyelitis (about 50 per 100,000 at the most susceptible ages, 27), the "acceptable" level of infectivity for a poliomyelitis vaccine would have to be very low indeed. If each particulate injected did cause a case of paralytic poliomyelitis, the injection of 1 milliliter of a vaccine containing 5 particulates per liter could cause up to 500 cases per 100,000 vaccinated. Of course, it is now clear from the Cutter incident that, as with natural infection, most individuals do not develop paralytic poliomyelitis when they are inoculated with live virus. The cases of poliomyelitis among contacts of children inoculated with Cutter vaccine (9) give evidence for the existence of numerous inapparent infections caused by the vaccine (28).

The White Paper thus proposed a test procedure which was designed to provide a known degree of protection. Unfortunately, the assumption of perfect sensitivity for tissue-culture preparations was not in accord with the experimental evidence. Even if one takes the more recent estimate (23) that the probability of infection by a single particle is about 0.02, one would have to multiply all test volumes by 50, a wholly impractical requirement, to achieve the degree of protection described in the White Paper.

Shortly after the Cutter incident, the Laboratory of Biologics Control of the Public Health Service requested outside laboratories to assist in testing incriminated and other lots of vaccine for the presence of live virus. The results of these tests were reported in the July 1956 issue of the *American Journal of Hygiene* (29). Of 16 Cutter lots tested, six had been clearly incriminated epidemiologically and ten had not. Since the supply of these vaccines was limited, none of the lots could be tested in tissue cul-

ture to the extent specified in the revised minimum requirements. Nonetheless the results were surprising. The tissue-culture test, previously believed to be considerably more sensitive than tests in monkeys, gave completely negative results in two of the three laboratories, and in the third laboratory it gave positive results for only two lots, one of which was not epidemiologically incriminated. However, two of the laboratories also made tests in monkeys pretreated with cortisone. All incriminated lots were found to infect a substantial proportion of the treated monkeys, and two additional nonincriminated lots were also found to contain live virus. Check tests showed that virus not treated with formaldehyde was more easily detected in tissue culture than in cortisone-treated monkeys. Evidently something happens in the process of treatment with formaldehyde which reduces the ability of virus to infect a tissue-culture preparation more than its ability to infect cortisone-treated monkeys. Although the reason for this phenomenon is not known with certainty, a mechanism which could give rise to such a result was described by Veldee in September 1955 (5).

At present, tests in cortisone-treated monkeys are incorporated into the minimum requirements. Thus, the epidemiologically incriminated Cutter lots would almost certainly not have passed the present safety test. However, the number of live virus particulates per liter which might plausibly escape detection by the present safety test is not known.

In addition to the review and revision of the safety test requirements, the Public Health Service initiated a study to determine the cause or causes of the failure of the manufacturing process to inactivate completely all of the virus. Each manufacturing plant was visited by a team of experts, and some changes in manufacturing procedures were introduced. In November 1955, the Public Health Service Technical Committee issued an interim report (30) in which it was stated that "the Committee is of the opinion that the principal factors which were involved in manufacturing difficulties have been identified and corrective measures have been taken." Precipitates had been found in some vaccine lots at various stages of production, and it was argued that virus might become trapped in a speck of precipitate and thus be shielded from the formaldehyde. The corrective measures proposed consisted of the addition of further filtration steps at certain stages in the inactivation process. The report offers no experimental evidence to support this theory, nor does it give evidence to show that improvement resulted from the introduction of the new filtration steps.

Meanwhile, it was considered desir-

able to revive the vaccination program as soon as possible. Throughout the summer and fall of 1955, lots were considered individually by the Public Health Service Technical Committee and released when the committee was satisfied that the lot in question had been adequately tested and proved safe. The criteria actually used for releasing lots under this system are not described in the report of the technical committee (30).

Discussion

The introduction of any new vaccine on a mass basis is always accompanied by a certain amount of risk that the vaccine may not be entirely safe. The degree of risk which ought to be tolerated depends, of course, on the incidence of the disease in question and the amount of benefit which the vaccine is supposed to offer. In view of the low average annual incidence of paralytic poliomyelitis—approximately 50 per 100,000 at the most susceptible ages—the introduction of a poliomyelitis vaccine can be justified only if the risk of acquiring poliomyelitis from the vaccine itself is known to be very small. Indeed, Salk himself has said that no vaccine could be justifiably introduced for which there existed any measurable risk at all (16). In view of the known deficiencies of the tissue-culture test and the inability of the manufacturers to produce consistently safe vaccines, the original decision to proceed with the field trial seems, in retrospect, unwise. Considering how little was known about the susceptibility of children to virus introduced by inoculation, one could not have ruled out the possibility that a vaccine containing live virus might produce more paralytic cases in a few weeks than would be expected from natural infections in many years. In practice, fortunately, it turned out that the clinical cases later produced by defective Cutter vaccine were only a very small proportion of the number infected (9).

The decision to proceed with the field trial may have been influenced by the fact that, of the 16 vaccine lots tested, the last ten had appeared to be free of live virus. However, continued production of vaccine while the field trial was in progress showed that both the inactivation process and the tissue-culture and monkey safety tests were unreliable. In any event, the assumption that the safety of the triple-tested vaccines used in the field trial was evidence for the safety of vaccines tested only by the manufacturer was not justified. In a recent paper (31), Salk suggests that improvements in the quality of vaccine production make possible the abandonment of the expensive safety tests with cortisone-treated mon-

keys. This weakening of the safety test would be extremely dangerous. Even if manufacturers are able to produce safe vaccine consistently, an adequate safety test is essential to guard against manufacturing accidents.

The adequacy of the present safety standards is difficult to judge. In view of all that remains unknown about the interaction of poliomyelitis virus and animal cell systems, a theoretical demonstration of the adequacy of even the present safety test requirements seems to be out of the question. However, testing procedures now incorporated into the minimum requirements have been able to detect the presence of live virus in the incriminated Cutter lots and also in some lots with which no cases of poliomyelitis were known to be associated. Although these findings by no means guarantee the adequacy of the current test requirements, they do provide some reassurance. The decision to proceed with the field trial and later to continue the vaccination program through the summer of 1955 seems, on the basis of the published evidence, to have been a gamble. Whether a gamble of this kind was warranted in this situation is a matter on which opinions will differ.

Perhaps the most disturbing element of the entire program has been the disparity between the risks that were known to be involved and the repeated assurances of safety. Before Salk's papers on safety testing had appeared (16, 17), it had become clear that this theory of inactivation did not in fact apply to the vaccine then being produced. Likewise, the implication that the experience in the field trial was strong evidence for the safety of the vaccine subsequently distributed was misleading. Finally, the statement that the fault in production had been determined and corrected seems, on the basis of the evidence presented in the report of the Public Health Service Technical Committee, a conjecture, rather than an experimentally determined fact.

The tendency to minimize the actual difficulties is not limited to these major instances. Many of the technical reports and publications which have appeared both before and after the Cutter incident have been vague about those facts which might open the status of the program to criticism. For example, the public statement preceding the field trial did not mention the finding of live virus, but asserted that "... the possibility of infectious activity remaining in any vaccine meeting the specifications and Minimal Requirements has been reduced to a point below which it cannot be measured by practicable laboratory procedures" (9). Without an assessment of the sensitivity of the practicable laboratory procedures, the statement is essen-

tially meaningless. Nonetheless, the statement was issued without further explanation. More recently, Ratner has pointed out (3) that the report on revised production methods (30) fails to indicate that the vaccine made by these methods was not available at the time the report was released and that the only vaccine that would be available for several months had been manufactured without the new safeguards and had been subjected to safety tests whose extent was not described. No reply to this letter or to Ratner's earlier article (2) seems to have been published.

If we consider the information which actually reaches the general public, the reports distributed to physicians by the National Foundation for Infantile Paralysis are probably more important than the technical reports of the Public Health Service committees. Although the reports of the National Foundation for Infantile Paralysis are ostensibly designed to explain the status of the program to physicians who will in turn give advice to parents, a rather biased picture emerges. All doubts about the safety of the vaccine are dismissed. It is said to be "as safe as any biologic product can possibly be," and it is stated that the safety of the vaccine "has become a question for historians rather than clinicians" (32, no. 3). To the query, "What is the estimated calculated risk of inducing poliomyelitis infection by the inoculation of vaccine under present safety standards?" the foundation reply is, "None. No risk" (32, no. 3). Despite the unresolved questions on the safety of the vaccine and the very small risk to any individual of acquiring paralytic polio in a single season, the foundation described the need for vaccinating as many children as possible before the 1956 polio season as "akin to a medical emergency" (32, no. 2).

As a matter of general policy, the failure to make complete information available and to answer serious criticisms seems unfortunate on several counts. For one thing, it makes it difficult if not impossible to have effective interaction between the scientific workers participating in the program and other scientists. It is not an uncommon finding, after all, that problems which are new in one field are familiar in another, though perhaps in a slightly different guise. Yet most researchers are unwilling to comment forcefully on what they know to be a limited portion of the evidence. If it had been generally recognized before the field trial that no guarantees of safety existed other than those outlined in Salk's paper in 1954 (16), individuals who remained silent might have made known their concern and urged a review of the safety testing program.

From the viewpoint of the relation-

ships between scientists and the general public, the consequences of this policy may be much more serious than the harm done by faulty vaccine. It is understandable that, having decided to proceed with a program, all concerned should wish to have it presented in the most favorable light. However, failure adequately to inform the public, more particularly the physicians who must largely accept the responsibility for advising the rest of the public, seems likely to lead to the deterioration of the confidence and respect which scientists should enjoy.

In view of the questions raised about the general policies adopted in the safety-testing program for poliomyelitis vaccine, a searching study of the entire program conducted by an appropriate body, such as the National Academy of Sciences, seems called for. Such a study could lead to recommendations for future programs which would provide for more complete access to information and, consequently, to more adequate protection from errors in judgment.

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Origins and Status of American Botanists

Charles J. Lyon

Scientists should learn more about themselves than is possible through personal observations. As a basis for maintaining the proper supply of trained men in each of the special fields, we should have accurate information about the number, ages, and professional preparation of the workers in each area. Such items as their academic origins and present fields of employment are also of considerable interest to many administrative officers.

In the absence of a central authority to regulate standards of training and the number of men in each field of science, the responsibility for advising students rests largely with individuals who depend too often on personal impressions and experience. They and the various planning agencies that can influence careers through fellowships and grants-in-aid should have information about the fields that require more men and about where these men can be trained to advantage.

With the exception of the *National*

Register of Scientific Personnel, the records for the biological sciences are few and quite out of date. The only recent analysis of the numbers and origins of professional botanists was reported in 1955 by Greulach (1), but it was based on the facts for 1943, as assembled in the seventh edition of *American Men of Science*. It was also limited in its objectives, with emphasis on the academic origins of 2015 workers. The publication of the ninth edition, in 1955, with the biological scientists in a separate volume (2), has provided the opportunity for a second study of the same group of mature scientists, now grown to more than 2700 in number. In addition to an analysis for some of the points that were developed in the Greulach study, the botanists of 1955 have been tabulated by age classes and nature of employment. The entire group has also been divided into the three major subgroups of (i) plant pathologists, (ii) plant physiologists, and (iii) the other botanists.

For the purposes of this study, a botanist has been defined as a scientist who lists his or her primary professional interest as being in one or more of the

plant sciences other than the applied sciences. Botanists are thus taken to include workers in plant nutrition, forest pathology, and economic botany, but the tabulation did not include geneticists, bacteriologists, foresters, horticulturists, agronomists, or plant breeders. Arbitrary decisions were made in the cases of scientists who were identified with some such field as cytology or biology; such a person was rated as a botanist only if a primary interest and activity in plant science was indicated by research titles, by membership in professional societies, or by his department in the organization by which he was employed. For the subdivisions of botany, a worker who indicated two such special fields as plant physiology and plant pathology was tabulated as having a primary interest in the area that he named first.

In tabulating such items as age, academic origin, and type of employment, certain other arbitrary decisions were necessary. For example, the age of an individual for whom no date of birth was recorded was taken to be about 21 years when the bachelor's degree was awarded. Only the first bachelor's degree, master's degree, and doctorate were tabulated. When only the advanced degree was reported, it was assumed (probably sometimes in error) that the bachelor's degree had been taken at the same institution. The occupation of a retired botanist was considered to be that shown by his last position before retirement. An important distinction had to be made in the many cases of botanists who were employed by the state colleges and universities; although most of them do research to some degree, they were tabulated under "education" if their official titles indicated that they were instructors in formal classes.

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Ages and Numbers of Botanists

The data for the birth years of botanists who were alive in 1955 are presented in Table 1, with the numbers recorded by decades through 1930. It could not be expected that men who were born after 1930 would appear in a directory of recognized scientists in 1955, and a correction for those born after 1925 had to be made in setting a reasonable figure for 1921-30. The major adjustment for this was made by tabulating data for the individual years of birth for the youngest botanists and by assuming that the number of men trained in each subdivision of botany would be essentially the same for those born in 1926-30 as for those born in 1921-25 and already listed in *American Men of Science*. This adjustment, plus a liberally estimated 15-percent allowance for such factors as the delaying effects of the military draft on men born in 1921-25, gives the adjusted data for this decade as 189, 235, and 307, respectively, for the physiologists, pathologists, and other botanists. This makes a total of 731 botanists born in 1921-30 in place of the 424 recorded in Table 1.

Comparison of this corrected total with the totals for all botanists born in the earlier decades (Table 1) shows a decrease in numbers of professional botanists trained in recent years. It is evident that the loss has come in the category of general botanists and in specialties other than physiology and pathology. Even with the allowances made for delay in the appearance of these young men in the directory, at least 100 fewer men of

this decade have become professional botanists than of the previous decade (1911-20), which showed no great gain over 1901-10.

Plant pathology has continued to enroll men at a steady rate of increase, although the upward trend is slow for workers born in this century. Something approaching an adequate level of supply of workers for the major problems of plant diseases may have been reached early in the century. Plant physiologists are the only group to show steady and rapid gains in numbers enrolled in each decade; in this group there is an increment of more than 40 for each of the last three decades of birth represented.

The failure to add as many men in general botany and in such specialties as anatomy, morphology, and taxonomy is understandable in view of the research trends of the times, but there is a real danger that failure to maintain the numbers of these botanists will result in a serious shortage of these scientists in the years not far ahead. Such men will always be needed, and the supply should be maintained in proportion as the total number of mature botanists rises with increases in population. Even the total increase in number of plant scientists, from 2015 to 2711 between 1943 and 1955, is not large when allowance is made for the relative inactivity of about 15 percent who were born 65 or more years ago. The National Science Foundation data on manpower (3, p. 24) in 1951 showed that the percentage of registered plant scientists then under 30 years of age was definitely lower than the percentage for any other field of biology.

To the extent that the trend of doctorates in botany can be used as an index of the training of professional botanists, the data compiled in *Doctoral Dissertations Accepted by American Universities* (4) show that the recent trend for botany is not encouraging. During the ten prewar years, 1933-42, the average number of doctorates in botany per year was 105.0 and the corresponding figure for zoology was 112.0. During the inactive years 1943-49, the number of doctorates in botany and zoology fell to 63.0 and 62.9 respectively. The numbers for botany and zoology during the postwar years 1950-55 have averaged 119.5 and 165.1, respectively, with botany falling away from a peak of 149 in 1953 to only 130 doctorates in 1955. These newly trained botanists have been, both relatively and actually, too few in number for the increase in population and professional openings during the past 15 years.

Academic Degrees

Although it is now an accepted standard of training for a professional career in botany, as in other fields of biology, that study for the doctorate should be undertaken as soon as possible, we know that this was not required in earlier years. The data in a biographical directory (*American Men of Science*) provide the facts for almost every man; those for botanists have been assembled in Table 2.

The results show a degree of graduate training in line with that of other scientists and higher than that for some. It is not surprising to find that the physiologists are equipped with the doctorate to the extent of more than 91 percent, since it is a strict requirement for all employment in this field of expert techniques.

The academic preparation of those in the "All others" group was not examined in detail because of the diversity of special interests, but no great variation from the average is to be expected. The subaverage showing of the pathologists, many of whom had only a master's degree, may reflect the listing of young workers, since 17 of the 98 who had only a master's degree had been born since 1920. However, the fact that most of the others in this group of 98 were born before 1900 indicates that the master's degree was once, but is no longer, considered adequate training for this specialty.

Undergraduate Origins

It is interesting and instructive to note the colleges and universities that have made significant contributions to the un-

Table 1. Botanists who were living in 1955, listed by categories according to the decades in which they were born.

Birth years	Pathologists		Physiologists		All others		All botanists	
	No.	Per-centage	No.	Per-centage	No.	Per-centage	No.	Per-centage
1880 or before	18	2.3	11	2.4	95	6.5	124	4.6
1881-1890	71	9.1	31	6.8	164	11.1	266	9.8
1891-1900	156	20.0	58	12.7	253	17.2	467	17.2
1901-1910	189	24.2	99	21.6	367	24.9	655	24.2
1911-1920	216	27.7	143	31.2	416	28.2	775	28.6
1921-1930	130	16.7	116	25.3	178	12.1	424	15.6
Total	780	100.0	458	100.0	1473	100.0	2711	100.0

Table 2. Highest academic degrees of professional botanists, 1955.

	Pathologists		Physiologists		All others		All botanists	
	No.	Per-centage	No.	Per-centage	No.	Per-centage	No.	Per-centage
Doctor's	660	84.6	418	91.2	1262	85.7	2340	86.3
Master's	98	12.6	26	5.7	211	14.3	371	13.7
Bachelor's or other	22	2.8	14	3.1				
Total	780	100.0	458	100.0	1473	100.0	2711	100.0

dergraduate and graduate education of the botanists of America. This is the topic so thoroughly treated by Greulach (1) for the professional workers of 1943. Since most of the 2711 botanists now listed in the 1955 edition of *American Men of Science* were covered by his analysis, the data can be expected to support many of his findings, and they do. The differences are also interesting, and some new points have been brought out.

The importance of the large universities, notably those that bear the names of the states, in launching professional botanists on their careers can be judged from Table 3. This table shows each American college and university that has 15 or more undergraduate alumni who are now listed as botanists. The 37 institutions listed in Table 3 that are sup-

ported largely by public funds account for the training of 45 percent of the 2640 living botanists, exclusive of 71 who took their bachelor's degrees in colleges outside of the United States and Canada. The emphasis on botany as a basic science for the agricultural courses in most of these public institutions accounts for the opportunities that they offer, but few of the 1180 workers trained in these institutions became specialists in applied botany, although some of them do research in that area.

The importance of the opportunity for thorough undergraduate training explains, in part, why 317 alumni of the 14 private colleges and universities that are listed in Table 3 chose careers as botanists. These institutions all have fairly large undergraduate enrollments,

but details of staff and equipment to teach plant science are probably more important in view of the absence from the list of such equally large private institutions as Colgate (1 botanist), Northwestern (10), Princeton (1), Smith (11), Swarthmore (5), Vassar (4), and Yale (8). The fact that 14 private colleges are listed in Table 3, whereas many state universities are not listed, is more difficult to understand, unless it be that the public institutions not on this list give more specific attention to botanical instruction for students who are on their way to careers in applied botany.

The marked productivity of certain liberal arts colleges that offer little or no graduate work in botany was noted by Greulach. He found that 12 of them, located, with one exception, in the area from Indiana to Pennsylvania, produced about 39 percent of the botanists from liberal arts colleges other than the University of Chicago, Harvard, Syracuse, and comparable institutions which emphasize graduate work.

His prediction of a change in the membership and ranking of this group has been verified. With the omission of the women's colleges of Wellesley and Smith, which still stand highest in their class, the ranking of these colleges is now: DePauw, Wabash, Oberlin, Butler, Dartmouth, Ohio Wesleyan (10 botanists), Earlham (9), Ohio University (8), Bucknell (5), Lebanon Valley (5), and Wooster (0). The only major change in ranking is that of DePauw, which does have some graduate work. There are now three other small colleges—Acadia, Colorado College, and Pomona, with seven botanists each—that have passed the last three of the original list, while Albion and Beloit now have five each. Without thorough analysis of the reasons for the significant contribution of these 16 relatively small colleges to botanical education, it is probably correct to attribute it to strong teachers and to administrative policies that allow them to work in separate departments of botany or their equivalent, as was noted by Knapp and Goodrich (5) in their study of some of the same colleges.

Despite the importance of the 51 institutions named in Table 3 in giving basic training for careers in botany, these account for the undergraduate origin of only 1497, or 56.5 percent of the bachelor's degrees. Although this is a notable contribution by about 5 percent of the colleges of America, it indicates a loss in their influence, since Greulach found that 63 percent of the botanists of 1943 had received their bachelor's degrees in approximately the same 51 institutions. The number of colleges that have at least one botanist on the alumni list rose from 303 to 401 in 12 years. This means that nearly 100 colleges, mostly small,

Table 3. Principal undergraduate origins of American botanists. Institutions that have 15 or more professional botanists among their alumni. (Numbers in parentheses indicate alumni with doctorate in botany awarded 1936-50.)

No. of botanists	Public (37)	Private (14)
107	California (Berkeley) (67)	
81	Minnesota (39)	
67	Wisconsin (30)	
58	Cornell (30)	
55	Nebraska (23)	
55	Ohio State (20)	
51	Massachusetts (18)	
		43 Chicago (23)
42	Illinois (17)	
42	Washington State (20)	
38	Michigan (23)	
37	Michigan State (8)	
36	Missouri (16)	
		34 Harvard (22)
33	Penn. State (21)	
32	Oregon State (14)	
31	Iowa State (17)	
30	Toronto (4)	
26	Kansas State (8)	26 DePauw (14)
25	Indiana (9)	25 Wabash (6)
24	Maryland (9)	
		23 Oberlin (7)
22	California (L.A.) (20)	
22	Idaho (18)	
		21 Butler (9)
		21 McGill (4)
20	Rutgers (9)	20 Dartmouth (8)
		20 Syracuse (15)
19	Clemson (7)	19 Columbia (13)
		19 Stanford (8)
18	Utah State (9)	
17	Maine (6)	
17	Saskatchewan (6)	
17	Washington (Seattle) (11)	
16	Arkansas (10)	
16	Colorado A. and M. (8)	16 Queens (Canada) (2)
16	Miami (Ohio) (21)	
16	North Carolina (17)	
16	Pennsylvania (9)	
16	Purdue (10)	
16	Texas (9)	
16	Utah (4)	
15	Cincinnati (8)	15 Geo. Washington (2)
15	West Virginia (11)	15 Wellesley (7)
1180	Totals	317

have started botanists on their careers in recent years.

The baccalaureate origins of men who obtained doctorates in botany at American universities from 1936 to 1950 have been reported in tabular form by Trytten (6). This analysis covers only the younger men who are sufficiently active as professional botanists to have been listed in *American Men of Science*, and there is bound to be a discrepancy between holders of doctorates and employment as professional botanists. Many such botanists have taken degrees in applied botany or other fields, and it appears that many holders of doctorates in botany from certain graduate schools (for example, Fordham, Catholic University, Radcliffe, and Louisiana University) do not become active enough as professional botanists to be recognized by *American Men of Science*.

For purposes of comparison between the two bases for studying academic origins of "botanists," the number of alumni from each institution listed in Table 3 who now hold doctorates in botany obtained in the period 1936-50 is shown in parentheses after the name of the institution. It is clear that the leaders are the same by either criterion, but the relative rating of some entries below the leaders in each column—for example, Miami University (Ohio) and Syracuse—would be changed appreciably if a recent doctorate in botany were used as the criterion. The reasons for the differences are too numerous to evaluate, and the principal data in Table 3 give a more accurate picture of the origins of the professional botanists of 1955.

Graduate Schools

The work of the graduate schools is not known to the scientific public in any detail in spite of their relatively small numbers. Individuals know the departments of their own specialty, but there is much variation in the productivity of graduate students over the years, as Greulach noted for the 68 American universities represented by 1640 doctorates held by the botanists of 1943. This number has now risen to 2293 doctorates in plant sciences, from 92 institutions; botanists of American college origin hold only a few doctorates from abroad.

The majority of these universities are shown in Table 4, listed in order of the number of doctorates awarded to botanists. The first 12 were also the leaders in numbers in 1943, with minor changes in the order of listing. There are now 56 graduate schools that have a minimum of three Ph.D.'s in plant science. These, as opposed to 46 schools in 1943, provide 98 percent of the total, but the

12 leaders still account for two-thirds of the doctorates, a loss of only 3 percent in the continuing dispersal of graduate training.

There have been some large gains and losses in the ranking of the other 44 most productive schools. Notable rises in rank in 12 years were made by Iowa, Rutgers, Duke, Purdue, North Carolina, and Oregon State, all tax-supported universities with the exception of Duke. Sharp losses in rank are recorded for Johns Hopkins, Pittsburgh, University of Washington (Seattle), Catholic University, Cincinnati, Syracuse, and Colorado, with a clear tendency for the privately endowed schools to be the principal losers. New names in the first 50 places are the University of California (Los Angeles), Kansas State, Northwestern, Fordham, Texas A. and M., and the five that tie with Syracuse, with four doctorates each.

A comparison of Table 4 with a corresponding tabulation of doctorates in pure botany from graduate schools in the United States, as reported by Trytten (6) in 1955, shows only minor differ-

ences in order of rating for most of the institutions. The first ten are in nearly the same order; the number of doctorates in botany for 1936-50 ranges from 138 for Wisconsin to 52 for Ohio State. Chicago dropped to fifth place, with 89, and Iowa State gained seventh place, with 76 doctorates for the same 15 years.

Of the next ten United States graduate schools that are listed in Table 4, eight appear in the same second group in the Trytten listing of doctorates for 1936-50, with Rutgers and Missouri displaced in rating by Louisiana and with a tie between Indiana and Virginia. Aside from other details of order of rating, the outstanding graduate schools of botany are essentially the same for the two sets of data.

It is of some interest to consider the extent to which the various graduate schools serve students from other colleges, as they must, since there are so few places where a Ph.D. degree may be earned under a full staff of experts. In this connection, a comparison of the first and second columns of figures under the heading "Ph.D." in Table 4 shows some

Table 4. Colleges and universities where American botanists did their graduate study and data on total number of doctorates and master's degrees from each. (Numbers in parentheses indicate candidates who received undergraduate degrees from other institutions.)

Institution	Ph.D.	M.A.	Institution	Ph.D.	M.A.
Wisconsin	257 (222)	146 (103)	Geo. Washington	9 (5)	11 (5)
Cornell	214 (184)	52 (38)	McGill	9 (4)	21 (9)
Chicago	174 (144)	84 (62)	Louisiana	7 (7)	19 (15)
California (Berkeley)	163 (113)	51 (24)	North Carolina State	7 (6)	15 (9)
Minnesota	140 (107)	94 (52)	Radcliffe	7 (6)	8 (6)
Harvard	123 (101)	102 (79)	Kansas State	6 (3)	20 (10)
Michigan	90 (68)	63 (41)	Northwestern	6 (5)	14 (9)
Iowa State	88 (64)	71 (51)	West Virginia	6 (3)	16 (6)
Columbia	86 (73)	45 (33)	Catholic	5 (5)	4 (4)
Ohio State	69 (42)	74 (38)	Cincinnati	5 (4)	10 (5)
Illinois	68 (54)	58 (38)	Fordham	5 (5)	4 (4)
Washington (St. Louis)	53 (44)	26 (16)	Kansas	5 (3)	10 (4)
Iowa	43 (37)	44 (35)	Texas A. and M.	5 (5)	10 (9)
Nebraska	41 (31)	42 (18)	Louisiana State	4 (2)	8 (5)
Toronto	39 (28)	28 (16)	Massachusetts	4 (2)	16 (3)
Rutgers	38 (31)	27 (19)	New York	4 (2)	3 (1)
Yale	38 (34)	23 (18)	Oklahoma	4 (4)	21 (16)
Pennsylvania	37 (26)	16 (7)	Syracuse	4 (1)	13 (3)
Duke	34 (31)	16 (11)	Vanderbilt	4 (4)	2 (1)
Maryland	31 (23)	28 (16)	Manitoba	3 (2)	4 (0)
Missouri	31 (12)	37 (13)	Alberta	2 (1)	10 (3)
Purdue	31 (25)	36 (27)	Arizona	2 (0)	6 (0)
Michigan State	27 (25)	42 (28)	Brown	2 (0)	8 (1)
Washington State	26 (16)	27 (16)	Colorado (U.)	2 (2)	17 (11)
Johns Hopkins	25 (22)	1 (1)	Laval	2 (2)	2 (2)
Stanford	22 (20)	16 (7)	Marquette	2 (1)	5 (1)
North Carolina	21 (14)	22 (12)	Montreal	2 (0)	1 (0)
Indiana	19 (12)	16 (5)	Notre Dame	2 (2)	2 (2)
Oregon State	17 (17)	16 (7)	Oregon	2 (2)	6 (4)
Pittsburgh	16 (12)	12 (6)	Rochester	2 (2)	1 (1)
Virginia	16 (14)	11 (7)	Utah	2 (0)	12 (2)
Calif. Inst. Tech.	15 (14)	1 (1)			
California (L.A.)	10 (5)	12 (3)	25 others with 1 doctorate each (some honorary) and a total of 73 master's degrees.		
Pennsylvania State	10 (5)	22 (9)			
Texas	10 (7)	13 (2)			
Washington (Seattle)	10 (7)	11 (3)			

differences among the universities represented by ten or more degrees. Of the 12 leaders, only Ohio State, California, and Iowa State drew on graduates of other colleges for less than 75 percent of their Ph.D. candidates. Of the schools that rank farther down the list, Oregon State, Michigan State, California Institute of Technology, Duke, and Stanford take at least 90 percent of their successful doctorate candidates from other colleges; Missouri is the exception in granting more than half of its doctorates to its own graduates.

In view of the great variation in data on the award of the master's degree, which is often only a step on the way to a Ph.D., a detailed analysis is not required. The data in Table 4 show the sources of most of the 2000 master's degrees that have been awarded to 2640 living botanists by 172 schools. The table reveals that several institutions frequently give 1 or 2 years of graduate work to their own alumni and to those of other institutions before these graduate students go elsewhere for their doctorates. Oklahoma, Colorado, and Massachusetts are good examples of such active schools.

This practice of beginning graduate work in one place and completing it elsewhere is, of course, not limited to the smaller graduate schools. The data indicate, for example, that Harvard, Ohio State, Iowa, Nebraska, and Michigan State not only award many Ph.D.'s in the plant sciences but also start some men on the road to doctorates from other institutions, although some of the numerous master's degrees from these large universities go to students to whom they later award the doctor's degree.

The relatively small number of master's degrees from Cornell, California, Johns Hopkins, and California Institute of Technology show the strong emphasis on the Ph.D. degree. In fact, the predominance in numbers of plant scientists who have doctorates over those who have only the master's degree speaks for the high standard of scholarship and preparation for careers in plant sciences everywhere.

Employment Categories

The status of botanists in the various professional occupations is of particular interest to young people and to their advisers in the schools and colleges. Teach-

Table 5. Employment categories of botanists who are listed in *American Men of Science*, edition 9.

	Pathologists		Physiologists		All others		All botanists	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Education	257	32.9	228	49.8	1099	74.6	1584	58.4
Government	419	53.7	129	28.2	151	10.3	699	25.8
Industry	68	8.7	52	11.3	86	5.8	206	7.6
Research	24	3.1	47	10.3	119	8.1	190	7.0
Private work	12	1.5	2	0.4	18	1.2	32	1.2
Total	780	100.0	458	100.0	1473	100.0	2711	100.0

ers know most about opportunities in education and in government work. Openings in industrial laboratories and research institutions are two other possibilities. Until quite recently, few data were available on the relative numbers of such possibilities. The National Science Foundation has published some information from the *National Register of Scientific Personnel* (3), and more may be expected to follow.

Some facts about the employment of the botanists in the 1955 edition of *American Men of Science* have been assembled in Table 5. The two large subdivisions of pathologists and physiologists were tabulated separately because of the special training and employment openings for such workers. The predominance of educational activities for all other botanists, as a group, confirms common knowledge, but the data for this group also reveal that openings can be found in industry and other research projects. It is evident that only the pathologists, as a group, depend heavily on government positions as their major source of employment. Physiologists are the most evenly distributed of all with respect to employment fields.

Industry seems to offer opportunities to a great variety of specialists in botany. These scientists are particularly needed for their skills in connection with industrial products from seeds, fruits, and fibers and from the varied biochemical transformations caused by bacteria and fungi. A study that is now being made by a committee of plant physiologists (7) reveals many openings for plant scientists in this area, with a possible shortage of men qualified to meet the needs of some industries. Much of the work in industrial laboratories or as consultants involves research for which botanists are well prepared.

Summary

The biographical data on botanists in the ninth edition of *American Men of Science*, supplemented by limited information from other sources, show a trend toward reduced numbers in the younger age groups, except for a continued increase in physiologists and a stabilized supply of pathologists. The 2640 botanists with bachelor's degrees from American colleges represent 401 undergraduate institutions, but more than half of them are alumni of a group of 37 large universities supported by public funds and 14 privately endowed colleges. More than 86 percent of the botanists have taken doctorates from 92 graduate schools, but 12 of the largest ones, located chiefly in the state universities, have provided two-thirds of these degrees; more than three-fourths of the candidates came from other colleges for their advanced training. Their fields of employment are predominantly in education and in government service, but appreciable numbers are doing research work for industry or in nonindustrial laboratories.

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K. Henke, Developmental Biologist

The untimely death of Karl Henke, professor of zoology at the University of Göttingen, on 14 September 1956, deprives the field of developmental science of one of its most original minds and German zoology of one of its most successful research workers and teachers.

Karl Henke was born in Bremen on 3 October 1895. He studied zoology in Göttingen and obtained his Ph.D. degree in 1923. He remained at the Zoological Institute in Göttingen until 1933, working with Alfred Kühn. In 1928–29 he was awarded a Rockefeller fellowship, which he used for work at Yale University in Harrison's laboratory. After returning to Germany, he became a *Privat-dozent* at Göttingen in 1929. In 1933 he accepted a position at the Kaiser Wilhelm Institute in Dahlem. In 1937 he was called to Göttingen as professor of zoology and director of the Zoological Institute, a position he held for the remainder of his life.

Henke's scientific work centered around the problem of the development of color patterns in animals, which he took as a model for the more general developmental problem of pattern formation. He brought to bear on the problem a large number of different techniques and the power of integration of his imaginative and disciplined mind. Together with Kühn he started out with the genetic and developmental analysis of the wing pattern of the meal moth *Ephestia*, which led to the recognition of the existence of systems of pattern elements which form a unit insofar as they vary concomitantly under the influence of genetic and environmental influences.

This concept was followed up by means of operative techniques which culminated in his fundamental work on the pattern determination on the wing imaginal disc of *Philosamia cynthia*, carried out at Yale. The same concept forms the basis of his monumental monograph on the variation of the wing pattern in the Saturniidae, in which he used the method of comparative morphology, not for the derivation of phylogenetic relations, but for the elucidation of the developmental mechanisms involved in pattern formation and in the integration of different pattern elements. The information obtained in these studies led to the recognition of developmental processes leading to the formation of fields and field boundaries in a previously uniform structure. This principle was extended, in a series of papers, to the color pattern formation in organisms other than Lepidoptera.

The second period of Henke's work centered around the problem of the determination of patterns at the cellular level. It was demonstrated that in the *Ephestia* wing the determination of scale, socket, and an abortive sensory cell is the result of two unequal cell divisions. In the further pursuit of this finding Henke succeeded in demonstrating that the determination of primordial scale cells, as opposed to primordial epidermal cells, is in turn the result of a series of differential cell divisions. Recognition of different degrees of polyploidy in the different types of scale cells and of the numerical relations between scales and epidermis cells on the wing led him to a theory called the "compensation principle," suggesting that the number of possible mi-

tozes is firmly determined for the primary stem cell, and that in successive mitoses this limited potentiality is differentially distributed to the daughter cells. Always cautious in his interpretations, he was engaged at the time of his death in collecting further evidence pertaining to this process.

Henke's scientific work is characterized by great care in the collecting of facts and caution in their evaluation. In choosing his problems, in the way he attacked them, and in the integration of his conclusions, he showed a highly imaginative way of thinking and a very independent and versatile mind. In this way, he has succeeded in leaving behind a well-founded basis of theory and fact which sheds light on one of the more perplexing aspects of development.

Henke's influence has been great, not only through his scientific work, but also through the impact of his personality on his colleagues, friends, and students. His manner combined modesty and reserve with a warm sense of humor and genuine wit. Many of his short statements will be remembered by his friends. The range of his interests was wide and encompassed philosophy as well as the arts. As a teacher he was highly stimulating and able to transmit his own high standards of scientific work to his students. Because of his complete integrity and his genuine kindness in human relations, he enjoyed the confidence of his colleagues and of his numerous friends.

As a result of this, he was called in his later years more and more into administrative tasks, which he fulfilled with his characteristic conscientiousness without regard to his own health. After World War II he had the task of rebuilding the Zoological Institute of Göttingen, which had burned. He served as dean of the faculty of sciences in Göttingen in 1955–56, was chairman of the biology panel of the Deutsche Forschungsgemeinschaft, and a member of the Akademie der Wissenschaften in Göttingen. Developmental biology has lost in him one of its most creative scientific minds, and German biology, one of its most trusted leaders.

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News of Science

European Manpower Mission

The Organization of European Economic Cooperation is sponsoring a survey of scientific manpower for its 16 member countries. Recognizing that an adequate supply of such manpower is the key to the future of Western Europe as a political, sociological, and economic entity, the OEEC's European Productivity Agency has organized a project to study the problem. During the next 6 weeks a small internationally representative group of specialists will visit the OEEC countries for discussions with governments, industrial institutions, private industry, and foundations. A national expert will accompany the group in each country to serve as a liaison man.

The project description proposed that the consultants assess the present situation and ascertain what future steps can be taken to (i) increase the training of scientists and technicians, (ii) attract more men and women into science, and (iii) create new systems of education more appropriate to current needs.

Dael Wolffe, executive officer of the AAAS and former director of the Commission on Human Resources and Advanced Training, is the leader of the team of scientific manpower specialists. Other members are L. Weil, professor of physics at the University of Grenoble; George S. Bosworth, director of technical personnel, recruitment, and training for the English Electric Company; and Toralf Hernes of the Norwegian Research Council for Technology and Sciences, rapporteur for the group. Six weeks after their return, these men will submit a report to the OEEC that will constitute the first step in the development of an extensive European program designed to meet collectively the need for a greatly increased supply of scientific manpower.

American Academy Grants

The American Academy of Arts and Sciences at its meeting in March reviewed 37 applications for grants from its Permanent Science Fund. Awards are made in support of research in any field of science whatsoever in amounts that ordinarily do not exceed \$1500. Appli-

cations for grants to be made in the early fall should be filed by 1 Sept. on forms available from the Chairman, Permanent Science Fund Committee, American Academy of Arts and Sciences, 280 Newton St., Boston 46, Mass.

Special consideration will be given to projects on new frontiers of science; those that lie between, or include, two or more of the classical fields; and those proposed by investigators who may be on the threshold of investigational careers or who are handicapped by inadequate resources and facilities. The committee does not ordinarily approve grants for research the results of which constitute partial fulfillment of requirements for an academic degree.

Satellite Observing Test

The first nation-wide test alert for satellite observers was held on 17 May under the direction of the Smithsonian Astrophysical Observatory, headquarters of Project MOONWATCH in Cambridge, Mass. Nearly 80 teams of visual observers, comprising about 1600 members, participated in the practice session, which provided the first trial of procedures to be followed when the earth satellite is launched during the International Geophysical Year.

The primary goal of the test exercise was to evaluate observing and communication techniques and to determine the state of readiness of the individual stations throughout the continental United States. This was the first national satellite alert ever to be held, and represented the largest organized astronomical observation ever to be made in this country. Throughout the country the test began 30 minutes after local sunset and ended 90 minutes later. Each team leader reported the results of his team's observations to MOONWATCH headquarters by code; Smithsonian Astrophysical Observatory officials collected and evaluated this information as it was received.

Although the practice session was only for the continental United States, MOONWATCH teams are being organized in other parts of the world. There are teams in Honolulu, Hawaii; and on the three Pacific Islands of Wake, Truk,

and Yap. Three teams are already registered in the Union of South Africa and several more are organizing there. Japan has 30 such visual observing teams. It is expected that 12 to 18 teams will be set up in South American countries, and there is organizational activity in the British Isles and Germany.

When the satellite is launched, position and time observations will be used to determine its orbit. The data will be fed into an electronic computer, which will calculate the predicted orbit. This information will then be transmitted to the 12 Smithsonian telescope-camera stations located at strategic points throughout the world. These cameras will make photographs from which precise measurements may be made and scientific conclusions deduced.

Texas Instruments British Subsidiary

Texas Instruments, Incorporated, electronics and geophysics firm in Dallas, Tex., has announced the formation of Texas Instruments, Limited, a wholly owned subsidiary to manufacture and sell semiconductor products in the United Kingdom. The new plant is now under construction in Bedford, 50 miles north of London. Both factory and offices will be contained in the 12,000-square-foot building that is scheduled for completion in June. Dudley Saward, a British citizen who has been associated with British European Airways, International Aeradio, and Barratt and Company, Ltd., has been appointed managing director of Texas Instruments, Limited.

Antarctic Manganese

An article for the *New York Times* by Walter Sullivan reports that a small vein of manganese silicate has been found in Antarctica. So far as can be determined, this is the first discovery of high-grade ore on that continent. The ore is in a rare form, known as tephroite, and was found on Clark Peninsula in Wilkes Land. The peninsula was visited for the first time in January of this year.

According to available records tephroite has been discovered in only three other places: Franklin, N.J.; Varmland, Sweden; and in the French Pyrenees. Brian H. Mason, curator of geology and mineralogy at the American Museum of Natural History, who identified the specimens, notes that in both Sweden and New Jersey tephroite is found in conjunction with extensive and valuable mineral deposits.

The ore has not been found in sufficient quantity in its three previously known locations to justify its being mined. Nevertheless it is a rich ore, bear-

ing from 60 to 70 percent manganese oxide.

Although the Antarctic Continent is far larger than Europe, no important mineral deposit has yet been discovered there. This is largely because of inaccessibility and because most of the continent is buried under an ice sheet that in places is more than 2 miles thick. Clark Peninsula lies on a part of the Antarctic coast from which the ice sheet has withdrawn, leaving about 100 square miles of land free from ice and snow.

Manganese has become a strategic metal because of its role in strengthening steel. The deposit on Clark Peninsula may not, of itself, be of commercial value, but it indicates that the region would be well worth exploring.

Wilkes Land lies in the sector claimed by Australia, although this claim is not recognized by the United States. A Soviet outpost has been established 265 miles to the west in an area known as Bunger's Oasis. The Australians, in recent months, have built a station still farther west, in the Vestfold Hills. These outposts were established for the International Geophysical Year and their stated objectives are nonpolitical.

The only overt rivalry is in the overlapping claims of Argentina, Britain, and Chile for Palmer Peninsula on the opposite side of the continent. This is a promising region because it appears to be a continuation of the Andes Mountains, which have enriched Bolivia with tin and Peru and Chile with copper.

Adolescent Sex Behavior

The American Social Hygiene Association will begin studies early this summer on sex behavior and venereal disease among adolescents. The first study, by the University of California in Los Angeles, probably will last a year. Martin Loeb, associate professor of social welfare, will direct the project, which is subsidized by the Mary Reynolds Babcock Foundation and the Child Welfare Foundation of the American Legion.

National Air Pollution Committee

Establishment of a National Advisory Committee on Community Air Pollution has been announced by the U.S. Public Health Service. The committee's first meeting will be held on 3 June in Washington. It will review the objectives, policies, and accomplishments of the program established by the USPHS under a 1955 Act of Congress and will make recommendations to the Surgeon General. The program has been basically one of research and technical assistance to states and communities attempting to

cope with the growing problem of community air pollution. Membership of the Advisory Committee will consist of Surgeon General Leroy E. Burney as chairman and 12 members representing state and local air-pollution control agencies, universities, industry, professional associations, and private consulting firms.

Jackson Memorial Laboratory Alumni Activities

The Alumni Association of the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me., has announced a plan to encourage the research interests of students and facilitate their preparation for careers in biological and behavioral science. Two alumni scholarships will be awarded at the end of the summer. One will enable a summer student in the laboratory's 1957 college and secondary-school groups to return for an additional apprenticeship in research in 1958. The other will aid a research assistant employed by the laboratory to continue advanced scientific study at a recognized graduate school.

Another program, still under development, calls for the establishment of a roster of Alumni Science Advisers. These older alumni throughout the country who are professionally established will be available to offer career advice and information to younger student alumni who reside or study in nearby areas.

The Jackson Laboratory is believed to be the only institution of its kind with a formally organized alumni unit. Members of the alumni association have been associated with the laboratory in various capacities ranging from assistants and student apprentices to professional scientists.

Carnegie Expands

The Carnegie Institute of Technology has announced the start of a \$24,350,000 building and development program. Of the total, \$7 million will go toward an expansion of the faculty and an increase in faculty salaries, at the rate of \$700,000 a year for 10 years.

Because the program will enlarge the College of Engineering and Science, another engineering and science building will be erected for \$2 million. Among many other improvements, a library building will be built for \$1.8 million.

The average yearly day-school enrollment at Carnegie is 3300 men and women. About 1800 students attend evening and summer sessions each year. To improve facilities for them, a campus activities center will be established for \$2.3 million. This project includes housing for married graduate students.

Buffalo Master's Program

New programs leading to master's degrees in the natural sciences and in the social sciences have been established by the University of Buffalo Graduate School of Arts and Sciences. These programs are particularly designed for teachers, librarians, technicians and others who desire additional work in a broad area while meeting special professional requirements.

Fields from which the courses may be chosen for the master of science degree in the natural sciences are biology, geology, mathematics, physics, and chemistry. Among the various fields of study in the social sciences program are anthropology, economics, geography, psychology, and sociology.

The Scientist and the Politician

Roger Revelle of the Scripps Institution of Oceanography recently made the following comments in a talk about "The scientist and the politician":

"It seems to me that the political education of scientists is a relatively straightforward problem. It can be accomplished primarily through training in the humanities. The essence of politics is that it deals with particular problems, not with generalities, and with unique problems that are never exactly the same as those that have arisen before. . . . The scientist must learn that men do not behave reasonably but in accordance with the patterns of their culture, that the human mind is not a logical machine. . . .

"In carrying out their political tasks scientists need also a breadth of knowledge of science itself. One essential part of the political education of scientists must therefore be to avoid a too narrow specialization. The physicist must be taught something of biology and geology if he is to play his proper role in political society.

"As for the scientific education of the politician I feel myself on less certain ground. I am convinced that it is not sufficient or perhaps even useful to offer him a series of survey courses in various scientific fields. These will serve only to freeze his understanding at a particular stage in the advance of science. It is far more important, it seems to me, to teach the future politician something of the nature of scientific discovery, the difficulty of finding out the truth, the objectivity, imagination and selflessness that are required, the fact that major discoveries always lie close to the frontier of science and not far beyond it, that such discoveries cannot be hurried by increasing money or effort but that once they are made they ramify in many directions with almost explosive speed. The politi-

cian should learn that fundamental scientific research is essential for technical progress, but that the results of basic research do not lead directly to application, rather they fill up the reservoir of knowledge at one end while that reservoir is being drained at the other end by technical advances. He should learn that scientists can make reasonably accurate predictions about technical possibilities and the rate of technical development, that scientists because they are intelligent and imaginative human beings, trained in objectivity and skepticism, can play a useful role in helping solve political problems. Finally the politician should learn that scientific discovery is slow and uncertain. It cannot be used to solve high priority immediate problems but only long-range questions."

Stevens Institute

Stevens Institute of Technology has begun construction of a seven-story science-engineering building. The \$2-million structure, which is expected to be ready for occupancy in the fall term of 1958, will house the departments of physics, metallurgy, and electrical engineering.

Purdue's Thermophysical Properties Research Center

At the first of the year Purdue University announced the establishment of a Thermophysical Properties Research Center with two long-range objectives: (i) To serve as a world center for research and to collect, analyse, correlate, and disseminate data on thermophysical properties; (ii) to provide unique facilities and opportunities for graduate study and research on thermophysical properties.

In this project, Government agencies and industry are cooperating by providing financial support. Each sponsor contributes approximately the amount of aid that might be given to a single graduate student, yet this amount allows participation in a major research program covering a broad field of application. This method of financing enables the university to enter upon interdisciplinary programs that otherwise could only be launched with great difficulty.

The program is under the immediate direction of Y. S. Touloukian, professor of mechanical engineering. At present he is forming a research staff of specialists in physical chemistry, physics metallurgy, chemical and mechanical engineering, and library science. By fall the staff will consist of ten full-time scientists and engineers assisted by graduate students. An advisory committee has been established

to serve as a consulting body and to coordinate all research on thermophysical properties conducted at Purdue.

The program is budgeted at \$75,000 annually for its first 3 years, and the list of founder-sponsors is constantly growing. A brochure describing the center's activities in detail is available to organizations interested in thermophysical properties. Inquiries should be addressed to Touloukian.

Loubat Prizes

Columbia University has announced the Loubat prizes. These prizes, established in 1892 through the generosity of Joseph F. Loubat, are awarded in recognition of the best works printed and published in the English language on the history, geography, archeology, ethnology, philology, or numismatics of North America. The two awards, one of \$1200 and one of \$600, are made by the university at the close of every quinquennial period. To be considered for the 1958 award, books must be published before the first of that year. The competition is open to all persons, whether or not they are connected with Columbia, and whether they are citizens of the United States of America or any other country.

Four copies of each work submitted in competition should be sent to the Secretary of Columbia University, New York 27, by 1 Jan. 1958. The address should state that the books are for the Loubat prize competition.

June Scientific Monthly

Articles appearing in the June issue of *The Scientific Monthly* are "Oil Shale and Bituminous Sand," F. L. Hartley and C. S. Brinegar; "Nautical Charting (1807-1957)," A. L. Shalowitz; "Sinkholes, Bottomless Lakes, and the Pecos River," E. R. Harrington; "Some Implications of the Study of Animal Behavior," W. H. Thorpe. Eight books are reviewed.

Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills introduced recently follows:

S 1699. Provide for establishment of a dairy research laboratory. Wiley (R Wis.) Senate Agriculture and Forestry.

S 1747. Provide for compulsory inspection by U.S. Department of Agriculture of poultry and poultry products. Ellender (D La.) Senate Agriculture and Forestry.

S 1756. Authorize Secretary of Agriculture to impose quarantines under cer-

tain circumstances in order to protect public from communicable poultry diseases. Williams (R Del.) Senate Agriculture and Forestry.

S 1763. Provide for research with respect to soil-water-plant relationships. Stennis (D Miss.) Senate Agriculture and Forestry.

HR 5948. Facilitate regulation, control, and eradication of plant pests. Roberts (D Ala.) House Agriculture.

HR 6422. Require use of humane methods in slaughter of livestock and poultry in interstate or foreign commerce. Loser (D Tenn.) House Agriculture.

HR 6512. Permit Secretary of Agriculture to prohibit exportation of national-forest timber. Pfost (D Idaho) House Agriculture.

HR 6684. Amend Soil Bank Act to permit grazing land to be included in conservation reserve program. Knutson (D Minn.) House Agriculture.

HR 6714. Amend Soil Bank Act of 28 Mar. 1956 in order to provide for greater utilization of technical services and facilities of state game and fish agencies in administration of conservation reserve. Jones (D Mo.) House Agriculture.

S 1727. Establish a program of Federal loans and loan insurance and encouragement of similar state programs for purpose of encouraging and assisting individuals to obtain college or university education. Javits (R N.Y.), Ives (R N.Y.), Cooper (R Ky.), Payne (R Maine), Beall (R Md.) Senate Labor and Public Welfare.

S 1731. Promote welfare of people by authorizing appropriation of funds to assist states and territories in further development of their programs of general university extension education. Hill (D Ala.) Senate Labor and Public Welfare.

S 1922. Authorize a 5-year program of grants for construction of medical and dental educational and research facilities. Hill (D Ala.), Kennedy (D Mass.), Neely (D W.Va.), Humphrey (D Minn.), Smathers (D Fla.) Senate Labor and Public Welfare.

HR 6164. Provide for establishment of U.S. Science Academy. St. George (R N.Y.) House Education and Labor.

HR 6420. Provide for construction of a fish and wildlife marine laboratory and experiment station in Brevard County, Fla. Herlong (D Fla.) House Merchant Marine and Fisheries.

HR 6771. Amend section 314 (c) of Public Health Service Act, to authorize Surgeon General to make certain grants-in-aid for support of public or nonprofit educational institutions which provide training and services in fields of public health and in administration of state and local public health programs. Rhodes (D Pa.) House Interstate and Foreign Commerce.

HR 6804. Encourage expansion of teaching and research in education of mentally retarded children through grants to institutions of higher learning and to state educational agencies. McGovern (D S.D.) House Education and Labor.

S 1917. Amend provisions of Public Health Service Act *re* grants for construction of research facilities to increase their duration from 3 to 5 years and to authorize grants for medical and dental teaching facilities. Smith (R N.J.), Purtell (R Conn.) Senate Labor and Public Welfare.

H Res 212. Appoint select committee to conduct full and complete investigation and study of use of chemicals and other additives in food and medicine, and beverages with view to ascertaining what deleterious effects such chemicals have on human life and health. Burdick (R N.D.) House Rules.

HR 7100. Revise, codify, and enact into law, title 21 of U.S.C., entitled "Food, Drugs and Animals." Willis (D La.) House Judiciary.

HR 6976. Provide for establishment of a Bureau of Senior Citizens within Department of Health, Education, and Welfare; provide for Assistant Secretary in such Department to direct said Bureau. Cramer (R Fla.) House Education and Labor.

Scientists in the News

LIEUWE J. DIJKSTRA, native of the Netherlands who has been serving since 1953 as an advisory physicist at the Westinghouse Electric Corporation's research laboratory, has been appointed to the staff of General Atomic Division of General Dynamics Corporation's John Jay Hopkins Laboratory for Pure and Applied Science, San Diego, Calif. He is a specialist in the properties of metals.

GEORGE W. BROWN, mathematician, will head the University of California's newly established Western Data Processing Center. He has been appointed professor of business administration and engineering and director of what is perhaps the first university computer center devoted primarily to the study of business management problems. The center, known as WDPC, was jointly announced last fall by UCLA and the International Business Machines Corporation.

The new facility is located on the university's Los Angeles campus, but it will be used by researchers and students from colleges and universities in 11 western states and Hawaii. Some 30 colleges and universities have already signified their intention of becoming participating members in the project.

MICHAEL HEIDELBERGER, visiting professor of immunochemistry at the Institute of Microbiology of Rutgers University, has been elected a member of the Royal Danish Academy of Sciences and Letters. Heidelberg, member of the staff of the institute since 1955, became emeritus professor of immunochemistry at Columbia University in 1956.

ROBERT D. FRANCIS, formerly in charge of the Poliomyelitis Diagnostic Unit at the Communicable Disease Center of the U.S. Public Health Service in Montgomery, Ala., has been appointed associate professor of microbiology at the University of Alabama Medical Center in Birmingham.

JOACHIM W. MUEHLNER, developer of several advanced missile electronic instrumentation systems, has been appointed a consulting scientist in Lockheed Missile Systems division's research and development branch at Palo Alto, Calif. He joined the missile division after more than 5 years as technical director of the range instrumentation development division, Army Ordnance, at White Sands Proving Ground in New Mexico.

Muehlner was one of the first German scientists brought to the United States after World War II, accepting a post with the War Department in 1945. Before coming to this country he was in charge of operation and field development of the velocity and position measuring system at the German Rocket Development Center, Peenemunde, from October 1942 to July 1945. This system was used as a long-range electronic trajectory-measuring system for the German V-2 rockets.

TRUMAN G. YUNCKER, emeritus botany professor and herbarium curator at DePauw University, has been granted a leave of absence from his curatorship for the year 1957-58 to participate in a continuing study of Jamaican flora at the University College of the West Indies in Jamaica. A specialist in the Piperaceae plant family, Yuncker served as DePauw's botany-bacteriology department head from 1921 until his retirement last June.

HARLAN I. FIRMINGER, professor of pathology and oncology at the University of Kansas Medical Center, has been appointed professor and chairman of the department of pathology at the University of Maryland. The new appointment is a part of the reorganization of the department begun last June when the former pathology head, HUGH SPENCER, retired after more than 40 years of service.

ROBERT M. HEXTER, assistant professor of chemistry at Cornell University, has been appointed a senior fellow in fundamental research at the Mellon Institute, Pittsburgh, Pa., effective 1 July.

WINIFRED ASPREY, chairman of the department of mathematics at Vassar College, has been granted a leave of absence for the academic year 1957-58 to accept a postdoctoral industrial research fellowship that has been granted to her by the International Business Machines Corporation. Fellowship recipients are furnished with working space at one of IBM's laboratory locations where they may attend internal seminars and meetings and share in the use of all facilities, including the most advanced IBM data processing machines.

Fellows receive individually determined financial support and are provided with the full-time assistance of one or more technicians, as their projects require. Dr. Asprey will conduct her research at the IBM Research Center in Poughkeepsie, N. Y.

NIELS BOHR, Danish physicist and Nobel prize winner who is to receive this year's \$75,000 Atoms for Peace award, has been appointed the Karl Taylor Compton lecturer at the Massachusetts Institute of Technology. He will be the first person to hold the Compton lectureship, which was established in honor of the late Dr. Compton, former president and chairman of the institute. Bohr will be in residence at M.I.T. during November.

EARL A. LONG, professor of chemistry, has succeeded CYRIL S. SMITH, professor of metallurgy, as director of the Institute for the Study of Metals of the University of Chicago. Smith, who has headed the institute since it was formed in 1945, resigned his administrative duties to devote full time to basic research in the physical structure of metal alloys. Long, a member of the institute since 1946, is in charge of its low temperature laboratory.

CHARLES R. MISCHKE, associate professor of mechanical engineering at the University of Kansas, has been appointed professor and head of the department of mechanical engineering of the Pratt Institute Engineering School, effective next September.

HOWARD H. NIEDERMAN, formerly principal propellant development engineer for the Aerojet-General Corporation, Azusa, Calif., has joined the staff of the Western Division of the Atlantic Research Corporation, which has its main office in Alexandria, Va.

JAMES L. CALVER has been appointed commissioner of mineral resources in the Virginia Department of Conservation and Development. He will also serve as state geologist of Virginia, succeeding WILLIAM M. MCGILL, who retired on 30 Apr.

The College of Medical Evangelists has announced that on 2 July the following men will retire: CHARLES M. GRUBER, professor and chairman of the department of pharmacology and experimental therapeutics, and OTTO KAMPMEIER, professor and chairman of the department of anatomy. MERVYN G. HARDINGS succeeds Gruber and HAROLD SHRYOCK succeeds Kampmeier.

JACOB A. MARINSKY of the nuclear division at Arthur D. Little, Inc., Cambridge, Mass., has been appointed by the University of Buffalo to serve as professor of chemistry and to help in the organization of a research program for its Nuclear Research Center. The appointment will become effective on 1 Sept.

ROY H. COOK, chief engineer of the Armament Division, White-Rogers, St. Louis, Mo., has been appointed professor and head of the department of mathematics in the Pratt Institute Engineering School, effective in September.

WACLAW SZYBALSKI, assistant professor of microbial genetics at the Institute of Microbiology of Rutgers University, has been elected an honorary member of the Italian Society for Experimental Biology for "illustrious work in experimental genetics of microbial resistance to antibiotics and pioneering work in genetics of bacteria and streptomycetes."

LYNN K. HURST, who joined Argonne National Laboratory as an associate chemist in 1943, has been appointed director of the laboratory's special materials and services division. He also has been named accountability representative for source and special nuclear materials.

WERNER A. BAUM, head of the department of meteorology at Florida State University, Tallahassee, since its establishment in 1949, has been appointed to the newly established position of director of university research. He will have administrative responsibility for the university's entire formal research program. Although discontinuing classroom teaching, he will continue to serve as head of the department of meteorology and as editor of the American Meteorological Society's *Journal of Meteorology*.

HENRY A. JONES, specialist in onion hybridization, has retired from the U.S. Department of Agriculture after 20 years of federal service. Before joining USDA in 1936, he was engaged in state college teaching and horticultural research for 18 years.

In 1925, while he was with the University of California at Davis, Jones discovered a distinctive form of male sterility in onions, which he later used successfully to develop a breeding method that made production of hybrid onions on a commercial scale practicable for the first time. As a result of his work, the output of Bermuda-type onions has doubled in Texas, and plant-breeding studies on a number of other crops have been greatly benefited. The method of onion hybridization pioneered by Jones—utilizing cytoplasmic male sterility—is applicable to all types of onions and is also being used in development of hybrid sorghums, sugar-beets, and field corn.

Jones received USDA's Distinguished Service award in 1953 for his achievements in horticultural research at the department's Agricultural Research Center, Beltsville, Md. In recent years, he has led cooperative federal-state work on development of hybrid varieties of spinach that are high-yielding and resistant to diseases such as blue mold and mosaic.

Following his retirement, Jones has joined the staff of a California seed concern as director of research. He will be stationed at El Centro.

Jones received his B.S.A. degree in horticulture at the University of Nebraska in 1916 and his doctorate in plant physiology at the University of Chicago in 1918. From 1919 to 1920 he was associate professor of horticulture at the University of West Virginia and associate horticulturist with the West Virginia Agricultural Experiment Station.

Appointed professor of vegetable gardening at the University of Maryland, he served 2 years at College Park before transferring to the University of California at Davis in 1922, where he became associate professor of truck crops and was later made head of the department. He remained at the University of California until 1936, serving as plant breeder and vegetable crops specialist in his later years there. Jones' career in Government service began in 1936 as principal horticulturist with USDA's former Bureau of Plant Industry.

He was awarded the William Herbert medal by directors of the American Amaryllis Society in 1943 for his outstanding contributions to onion cytology, breeding, and culture. In 1944 he was joint recipient, with Alfred E. Clarke, of the Vaughn Research award for a paper describing male sterility in the onion and production of hybrid onion

seed. Jones received the honorary degree of doctor of science from the University of Nebraska in 1952, and in 1955 he was named "Vegetable Man of the Year" by the Vegetable Growers Association of America.

ISIDORE FINKELSTEIN has joined the Servo Corporation of America, New Hyde Park, N.Y., as a physicist in the company's electronics laboratory. Prior to joining Servo, he served as executive director of the Optometric Center of New York, which he helped organize. He was an assistant professor of Optometry at Columbia University for 24 years.

MICHAEL G. MCGRAW has been named director of the School of Electrical Engineering, International Correspondence Schools (Scranton, Pa.). He fills the vacancy created by the death of the former director, CHARLES H. SPRAGUE. McGraw joined the I.C.S. School of Mechanical Engineering in 1953; in 1954 he was appointed assistant director of the Mechanical Engineering School.

ALBERT C. ZETTLEMOYER, professor of chemistry and research director of the National Printing Ink Institute at Lehigh University, has been selected to present the Joseph J. Mattiello lecture at the 35th annual meeting of the Federation of Paint and Varnish Production Clubs, which is to be held 30 Oct.-2 Nov. at the Bellevue Stratford Hotel in Philadelphia, Pa. The title of his lecture, which will be the feature technical presentation of the meeting, is "The pigment-vehicle interface."

Recent Deaths

FRANCIS G. BENEDICT, Machiasport, Me.; 86; former director of the nutrition laboratories of the Carnegie Institution of Washington; 14 May.

J. BROWNLEE DAVIDSON, Ames, Iowa; 77; former head of the agricultural engineering department at Iowa State College; 8 May.

LAURA FLORENCE, Rocky Hill, N.J.; 75; retired professor of bacteriology at the New York Medical College-Flower and Fifth Avenue Hospitals; 10 May.

JAY L. HOFFMAN, Washington, D.C.; 47; psychiatrist at St. Elizabeth's Hospital and associate professor of psychiatry at George Washington University Medical School; 11 May.

Erratum: In the "News of science" section for 19 Apr. we reported that next fall Wayne State University would be the second school in the country (Harvard was first) to offer a master's degree in automatic data processing. A reader informs us that Stevens Institute of Technology offered such a program in 1956-57.

Reports

Specificity of a Glucose

Oxidase Test for Urine Glucose

Most tests for urine glucose depend on the reduction of cupric or bismuth compounds. Such tests are not specific, for other reducing sugars as well as nonsugar reducing substances will give positive reactions when they are present in the urine in sufficient concentration. Recently, a test for urine glucose has been devised which employs the enzyme glucose oxidase.

In this test, glucose is oxidized to gluconic acid and hydrogen peroxide, the reaction being catalyzed by the enzyme. The hydrogen peroxide oxidizes orthotolidine in a reaction catalyzed by peroxidase. The enzymes and indicator are impregnated on a stick of stiff filter paper (1). The detection of glucose in urine is readily accomplished by dipping the test stick in the urine sample and observing at the end of 1 minute. Development of a blue color denotes the presence of glucose; the test is negative if no blue is seen at 1 minute. One of the outstanding features of the test composition is its specificity in detecting glucose as differentiated from other reducing sugars or nonglucose reducing substances. This report describes studies that establish the high specificity of this test.

The minimum concentration of sugar which gave a positive reaction with the enzyme test was established by testing various dilutions of the sugars in urine and water. Since most sugars prepared from natural sources may contain variable small amounts of glucose, it was essential also to test the sugar after removal of the glucose. Glucose can readily be removed from either urine or an

aqueous solution by adding powdered glucose oxidase and aerating the mixture.

Twenty-percent solutions of the various sugars were prepared, using both distilled water and normal urine as the solvent. Serial dilutions of the sugar were then made at twofold intervals, using water as the diluent with the aqueous solutions and urine as the diluent with urine solutions. For removal of glucose, a 20-ml aliquot of sugar solution was mixed with 500 mg of glucose oxidase (Takamine-crude powder), and the mixture was aerated by passing approximately 400 ml of air per minute for periods ranging from 1/2 to 4 hours, depending on the amount of glucose to be removed. New serial dilutions were then prepared from the aerated solutions. The fact that the glucose oxidase had not significantly changed the amount of nonglucose-reducing substance was confirmed with a quantitative copper-reduction method.

Table 1 shows the results obtained with solutions of 11 different sugars, when mixed with urine. Quite comparable results were obtained when the same sugars were studied in aqueous solution, but in water the enzyme test is at least five times more sensitive. Two samples of galactose were included in the study, one of which was labeled practical and the other C.P. A useful control which was also included was a mixture of 95 parts of galactose (C.P.) and 5 parts of glucose (C.P.). Commercial galactose, fructose, mannose, maltose, and xylose reacted at fairly low concentrations with the enzyme test (0.05 to 1.0 percent in water, 0.2 to 5 percent in urine).

It is evident that the reactivity of the glucose oxidase test sticks with the sugar solutions was due to contaminating glucose, since treatment with glucose oxidase abolished the ability of all of the solutions except galactose to react at even a 20 percent concentration of sugar. With the chemically pure galactose, a reaction with the glucose oxidase test stick did occur at 20-percent concentration, but since the ratio of activity of this material before and after treatment is comparable to that of the more impure galactose, it may well be that this

is caused by residual glucose impurities. That no significant amount of nonglucose-reducing sugar disappeared is shown by the values obtained with the copper-reduction method after treatment with glucose oxidase.

When an attempt was made to confirm further the presence of glucose as a contaminant by applying the classical method of yeast fermentation, an unexpected limitation was found. Galactose solutions aerated along with glucose oxidase gave negative enzyme stick tests, but after they had been mixed with washed yeast for a few minutes, they gave trace reactions with the stick test. The same result to an even greater extent was obtained with fructose solution. Since washed yeast gave negative tests with the enzyme composition, it appears that minute amounts of these sugars are converted to glucose by the yeast. While the amounts of glucose formed are quite small, this suggests possible limitations of the classical yeast method.

Data in this report differ somewhat from those reported by Keilin and Hartree (2). Using a manometric method, these workers found that a glucose oxidase from *Penicillium notatum* catalyzed the oxidation of xylose and galactose at a rate about 1 percent of that of glucose. Eleven other sugars were oxidized to a minute degree. It is evident that their methodology was different, and accordingly the difference in the results obtained in this study as compared with the observations of Keilin and Hartree may be due to a difference in the enzyme, to a difference in the conditions used for

Table 1. Reactivity of various sugars in urine with glucose oxidase test sticks.

Sugar	Minimum concn. giving positive test (%)	
	Untreated	Aerated with glucose oxidase
Galactose (practical)	0.2	10
Galactose (C.P.)	0.5	20
Fructose	2	Neg. at 20
Lactose	Neg. at 20	
Mannose	2	Neg. at 20
Maltose	1	Neg. at 20
Sucrose	Neg. at 20	
Xylose	5	Neg. at 20
D-Ribose	Neg. at 20	
D-Arabinose	Neg. at 20	
L-Arabinose	Neg. at 20	
L-Xylulose	Neg. at 20	
95 parts galactose (C.P.) and 5 parts glucose (C.P.)	0.1	5

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

the reaction, or possibly to the presence of minute amounts of contaminating glucose in their samples.

The minimum concentration of glucose which reacts with the enzyme stick is about 0.002 percent in water and 0.01 to 0.05 percent in urine. This indicates the small amounts of glucose that would have to be present in the commercial sugar samples to give the results obtained. It is impressive that, after glucose removal, none of the sugars in urine gave a positive reaction at a concentration less than 20 percent. This concentration is much more than is ever encountered in any of the benign meliturias (3). Accordingly, the specificity of the test is demonstrated.

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References and Notes

1. These sticks for detection of urinary glucose are supplied by the Ames Company of Elkhart, Ind., under the registered trademark of Clinistix.
2. D. Keilin and E. F. Hartree, *Biochem. J. (London)* 42, 221 (1948).
3. J. C. Bock, *Physiol. Revs.* 24, 169 (1944).

7 March 1957

Effect of Bone Marrow Treatment on Mortality of Mice Irradiated with Fast Neutrons

Lethality following acute whole-body x-ray irradiation of laboratory animals can be greatly reduced by injecting a suspension of normal bone marrow cells into the animals after irradiation (1). Increases in the probability of recovery of guinea pigs following chronic gamma-ray irradiation and following the mixed radiation from an intravenous injection in mice of a sodium citrate solution containing radon in equilibrium with its decay products have also been reported for the same bone marrow treatment (2). A further test of this treatment for mice following irradiation by fast neutrons is described in this report (3).

The mice, usually 12 weeks old, were placed in individual perforated plastic tubes at a distance of 15 cm from the target of a Cockcroft-Walton accelerator. They were then irradiated with 14.1-Mev neutrons produced by the $H^3(d,n) He^4$ nuclear reaction. The dose rate in wet tissue was 100 to 200 rad/hr. There was little gamma contamination (4). In each experiment, the dose was determined by the use of two simultaneous monitors. Isologous bone marrow was taken from the femurs of normal mature animals, suspended in Tyrode's solution, and injected intravenously into half of the irradiated animals within a few hours after

the completion of irradiation. In all but one experiment reported here, each treated mouse received the bone marrow taken from the shafts of eight femurs. Control and test animals were identically caged, 3 to 6 to a cage. Purina laboratory chow and water were supplied *ad libitum*. In all experiments, survival was checked daily up to 30 days, and in some experiments average body weights of treated and control groups were followed.

Table 1 gives the mortality results for seven experiments and the totals for all experiments. In every experiment, the 30-day mortality was greater among the control animals than among the animals treated with bone marrow. The most pronounced effect of the treatment was the 5/1 reduction in the totals in the probability of mortality during the second week of animals surviving the first week. Ninety-seven percent of all deaths occurred within 2 weeks after irradiation.

Applications of the chi-square statistic to the totals indicated that the reduction in mortality following bone marrow treatment was significant at the 1-percent level for 30-day mortality, 14-day mortality, and mortality during the second week, and at the 4-percent level for 7-day mortality, but was insignificant for 5-day mortality. Applications of the three-dimensional chi-square test (5) to the totals of LAF_1 and $101 \times C_3HF_1$ mice indicated that: (i) at the 10-percent level, bone marrow treatment of LAF_1 mice was more effective than treatment of $101 \times C_3HF_1$ mice, but this may be because of differences in the mortality levels in controls for the two strains; and (ii) that there was no significant difference in the effectiveness of treatment of males versus females.

Curves of the average weights of the survivors at each day for the first three experiments showed that the control animals reached a minimum of about 73 percent of their initial weight at 8 days postirradiation but asymptotically approached the initial weight at 30 days. The bone marrow treated animals reached a minimum of about 76 percent of their initial weight at 6 days and asymptotically approached their initial weight at 30 days. The effects of smaller doses of bone marrow are being investigated. The mortality among control animals exposed at these dose rates to 14-Mev neutron irradiation was somewhat lower and later than the reported values for equal irradiation by lower energy neutrons at higher dose rates (6).

The fast neutron doses administered were chosen to produce more than 50 percent mortality at 30 days in control animals. The dose required to meet this condition is a function of the dose rate, average linear energy transfer and probably the ratio of dose to bone marrow to that to the gastrointestinal tract. An investigation of the relative biological effectiveness for acute lethality in the RF strain of mice as a function of these parameters is in preparation (7). The higher concentration of elements with atomic weights greater than 20 (for example, calcium and potassium) and lower concentration of hydrogen in bone than in wet tissue tend to make the ratio of bone marrow dose to tissue dose other than unity. The ratio of the first collision dose rate in a large homogeneous bone to the dose rate in wet tissue exposed to the same 14-Mev neutron flux is estimated as about 0.75. This value is only an approximation to the value ob-

Table 1. Effect of bone marrow treatment on mortality from fast neutrons.

Strain	Sex	Dose (rad)	Treatment	Mortality* during days		
				0-7	8-14	0-30
RF	M	715	Bone marrow†	3/10	1/ 7	6/10
RF	M	715	None	1/10	9/ 9	10/10
$101 \times C_3HF_1$	M	837	Bone marrow	2/12	1/10	3/12
$101 \times C_3HF_1$	M	837	None	3/11	2/ 8	5/11
$101 \times C_3HF_1$	M	906	Bone marrow	7/12	1/ 5	8/12
$101 \times C_3HF_1$	M	906	None	7/12	4/ 5	11/12
$101 \times C_3HF_1$	F	877	Bone marrow	3/11	0/ 8	3/11
$101 \times C_3HF_1$	F	877	None	9/12	2/ 3	11/12
$101 \times C_3HF_1$	F	902	Bone marrow	0/12	1/12	1/12
$101 \times C_3HF_1$	F	902	None	3/12	1/ 9	5/12
$101 \times C_3HF_1$	F	902	None	1/12	3/11	4/12
LAF_1	M	900	Bone marrow	6/12	6/ 6	12/12
LAF_1	M	900	None	1/10	0/ 9	1/10
LAF_1	F	800	Bone marrow	2/12	6/10	8/12
LAF_1	F	800	None	17/79	7/62	26/79
Total			Bone marrow	21.5	11.2	32.9
Percentage			None	31/81	30/50	62/81
Total			None	38.3	60.0	76.5
Percentage			None			

* The numerator gives the number of mice that died during the interval and the denominator gives the number living at the start of the interval.

† Each of these mice received bone marrow from only 3 donor femurs.

taining in the bone marrow of a mouse because of the uncertainties in atomic composition of bone and bone marrow and because of the lack of homogeneity of composition in volumes encompassing the range (up to about 2 mm) of the recoil protons (the most important and energetic ionizing particles produced by fast-neutron irradiation). In contrast to the fast-neutron case, in typical x-ray irradiations, this ratio in homogeneous bone is perhaps 3 (8), and the applicable value of the ratio is subject to the same kinds of uncertainties as for neutron irradiation. Also because of the relative compositions, the ratio of the average linear energy transfer in bone to that in wet tissue is probably less than unity in photon irradiations and greater than unity in neutron irradiations.

In a general way, most acute irradiation deaths have been classed as caused by gastrointestinal or bone marrow damage (9). In gastrointestinal damage, deaths in mice tend to occur within less than 7 days after irradiation and in bone marrow damage during the second week after irradiation. Considering the characteristically sharp break in the shape of mortality versus dose curves and the ratios of dose in bone to that in wet tissue, one might anticipate that a change from x-ray to fast-neutron irradiation would markedly increase the percentage of gastrointestinal deaths in irradiations with equal over-all mortality. This has been found by various workers. Furthermore, owing to the increase in gastrointestinal death, against which bone marrow treatment is expected to be ineffective, one might anticipate that bone marrow treatment would be less efficacious against death (from all causes) following fast-neutron irradiation than following x-ray irradiation. At best, the frequency distribution of mortality might be shifted to that of gastrointestinal death alone.

Comparison of the results of the present fast-neutron irradiation experiments, in which bone marrow treatment produced a significant reduction in mortality only after the period assigned to gastrointestinal death, with previous x-ray irradiation experiments (1) supports these conclusions.

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References and Notes

1. E. Lorenz *et al.*, *J. Natl. Cancer Inst.* 12, 197 (1951).
2. E. Lorenz and C. C. Congdon, *Proc. Intern. Congr. Intern. Soc. Hematol.*, 4th Congr., 192 (1954).
3. This work was performed for the Oak Ridge National Laboratory, operated by Union Carbide Nuclear Company for the U.S. Atomic Energy Commission.
4. M. Slater, G. B. Bunyard, M. L. Randolph, in preparation.

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7. M. L. Randolph, J. A. Sproul, A. C. Upton, in preparation.
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4 March 1957

New Principle of Preparative Electrophoresis

Electrophoresis is potentially the most elegant and efficient method for protein fractionation and isolation. Even before the adaptation of the method to analytic purposes by Tiselius, there were numerous attempts to utilize it for preparative purposes. The older literature has been well reviewed by Svensson (1) and the more recent upsurge of various apparatus designs has also been partially reviewed (2).

Some of the older electrophoretic methods were based on the electrode-cantation principle of Pauli (3). Proteins, and other charged colloids, when exposed to a direct-current electric field will migrate toward one of the electrodes and, therefore, will accumulate in the immediate neighborhood of a semipermeable membrane placed in their path of migration. This layer of increased colloid concentration will, by virtue of its higher density, settle to the bottom of the vessel, where it can be withdrawn separately from the bulk of the solution. This principle was also adopted by Kirkwood *et al.* (4) in the electrophoresis-convection method, using certain elements of the Clusius column.

Based on the fact of the accumulation of charged colloids in the immediate neighborhood of a semipermeable membrane, a new method of preparative electrophoresis was developed, which is best described by the functional name, *continuous free-boundary flow-electrophoresis* (5). The method takes advantage of the laminar flow of liquids, and its principle can be illustrated with the aid of the diagram presented in Fig. 1. An electrophoretic cell is constructed of two outer semipermeable membranes *A* and *A'*, defining the size of the cell, and held stretched in a plastic frame (not shown in the diagram). The cell is immersed in a circulating, cooled buffer, and a direct-current electric field can be established across the membranes. The two membranes are kept parallel, 3 to 4 mm apart, while a third semipermeable membrane *B* is inserted between them part way into the cell. The cell is thus divided into three compartments, two at

the top and a common one at the bottom. All three compartments have means for continuous input or withdrawal of the colloid solution.

If it is assumed that the solution to be fractionated contains two proteins, differing in their electrophoretic mobility or isoelectric points, then the *pH* of the solution and of the outside buffer is adjusted close to the isoelectric point of one of the proteins. The solution is continuously fed into one of the top compartments, and the polarity of the current is selected so that the other protein, the mobile one, migrates toward the outer membrane of the compartment, as indicated by the short arrows in Fig. 1. The rate of flow of the vertical column of liquid is adjusted so that the migrating protein can reach the outside membrane by the time the liquid containing it reaches the bottom of membrane *B*. This migrating protein will have formed a layer of increased concentration in the immediate neighborhood of the outer membrane, and will be withdrawn quantitatively in that part of the liquid which is collected through the bottom compartment. The other protein, at, or close to the isoelectric point, will not have been influenced by the electric field, and will therefore be uniformly distributed throughout the liquid. It can therefore be withdrawn from the other top compartment.

The inflowing liquid is thus separated into two fractions. The bottom fraction contains all the migrating proteins, but

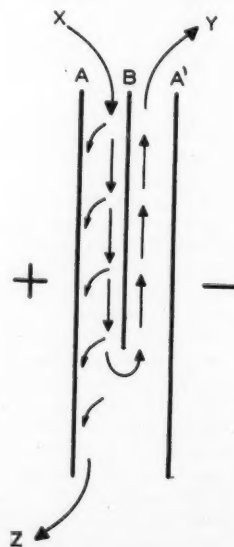


Fig. 1. Continuous free-boundary flow-electrophoresis apparatus. *A*, *A'*, outer membranes; *B*, intermediate membrane; *X*, input of solutions; *Y*, *Z*, withdrawal of solutions.

is still contaminated with the isoelectric protein in its original concentration. The second fraction, obtained at the top of the cell, contains only the isoelectric protein, in a state of electrophoretic purity, with all the mobile protein eliminated.

The method has the added advantage that the rates of withdrawal of the solutions from the top and bottom of the apparatus can be controlled independently, the flow through the top outlet being adjusted, for example, to 4 times the flow through the bottom outlet. Accordingly, in a single circulation of the solution through the apparatus, it is possible to obtain 80 percent of the isoelectric protein in a state of electrophoretic purity at its original concentration, while all of the mobile component is obtained concentrated fivefold, admixed with only 20 percent of the initial amount of the isoelectric protein. The ratio of the two outflows can be varied to an even greater extent, or the bottom fraction can be recirculated, if greater recovery of the isoelectric component is desired. The method can thus be used either for the preparation of electrophoretically pure proteins or for the concentration of protein solutions, as may be desirable, for example, in highly dilute enzymatically active metabolic filtrates.

The rate of flow obtainable in a given system will depend on the electrophoretic mobility of the mobile components—the greater the mobility, the higher the rate. It will also depend on the intensity of the electric field applied, which is limited only by the total power that the cooling system will dissipate. With a constant-ampere input, little is gained by changing the cross-sectional area of the cell, and cells have been used whose cross-sectional areas varied from 125 to 13 cm², the latter being preferred at present (6). For a given cell and constant power, the field strength increases inversely with the ionic strength of the buffer. This makes buffers of low ionic strength preferable.

Up to the present, the various cells have been employed mainly on two systems. One application was the concentration of hemoglobin solutions, this being a particularly convenient system, as the concentration can be determined colorimetrically. Rates of flow up to 4 ml/min were obtained, using an input of 2 amp and a sodium barbiturate buffer, 0.02M, at pH 8.6. The other application was the isolation of γ -globulins from half-diluted human plasma. The same buffer was employed, and comparable rates of flow yielded an 80 percent recovery of electrophoretically pure γ -globulins in a single passage through the cell.

The flow rate of 4 ml/min obtainable

with the apparatus is of the same order of magnitude as the per day output of some of the hanging-curtain paper electrophoresis instruments employed at present. It can also be favorably contrasted with the electrophoresis-convection method, which yields about 100 ml per batch, the processing of which may require 24 hours or more. The output of the present method can also be conveniently multiplied by arranging a series of cells in parallel. The power consumption for such an arrangement would not be considerably increased, while the output would be multiplied by the number of cells used. Accordingly, flow rates can be achieved which may be of importance for the industrial preparation of electrophoretically pure proteins (7).

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15 March 1957

Mechanism of the Erythropoietic Effect of Cobalt

It has long been known that cobalt ion increases the rate of erythropoiesis in man and in experimental animals and will eventually produce and maintain a polycythemia (1). More recent work (2) has demonstrated that the earlier suggestion that cobalt exerted its effect by making the bone marrow anoxic (3) is untenable.

With increasing attention being paid to the role of the plasma factor, erythropoietin, in the control of erythropoiesis (4), and with the availability of simple, short assays for this hormone (5, 6), we have investigated the possibility that cobalt may be effective through erythropoietin production. The data presented in this report indicate strongly that cobalt enhances red-cell production by increasing the formation of erythropoietin.

Male Sprague-Dawley rats (400 to 450 g) were given subcutaneous injections of CoCl₂ (3 ml containing 75 μ mole plus 2 μ c of Co⁶⁰). Ten hours later, the animals were bled by cardiac puncture, and enough blood was with-

drawn so that a minimum of 20 ml of "cobalt plasma" was available for assay. The amount of cobalt remaining in the plasma, determined from the Co⁶⁰ content, was 0.21 μ mole/ml. The cobalt plasma was assayed by the Fe⁵⁹ incorporation method in starved rats (7) using normal plasma with 0.21 μ mole/ml of CoCl₂ as the control. The incorporation of Fe⁵⁹ into the red blood cells of rats that had been treated with these preparations of plasma was compared with that of rats that had been treated with plasma obtained from animals made anemic by the injection of phenylhydrazine.

After 1 day of starvation, rats were given two intravenous injections of 2 ml each at 1-day intervals while starvation was continued. On the fourth day of starvation, 1 μ c of Fe⁵⁹ citrate was injected into the tail vein, and 18 hours later, 1 ml of blood was removed and counted in a well-type scintillation counter. The percentage incorporation of the injected radioiron was then calculated as described previously (5). Average values for four experimental groups of five or more animals are as follows: cobalt plasma (containing 0.21 μ mole of Co⁺⁺ per milliliter), 13.9 percent (± 2.6); normal plasma (with 0.21 μ mole of Co⁺⁺ per milliliter added), 3.1 percent (± 0.6); anemic plasma, 15.1 percent (± 3.3); and normal plasma, 2.8 percent (± 0.9).

The pronounced increase in the incorporation of Fe⁵⁹ that was produced by the cobalt plasma cannot be the result of the presence of a small amount of cobaltous ion but can be interpreted as being the result of the presence of an increased amount of erythropoietin in the plasma. It is possible, however, that a form of cobalt other than cobaltous ion is responsible for the observed effect. When erythropoietin has been characterized more fully, it will be possible to determine whether cobalt plasma contains the factor identical with that found in anemic plasma.

We have accumulated some evidence showing that certain of the properties of erythropoietin in anemic plasma are also common to those of the active factor in cobalt plasma. The erythropoietic activity of both anemic and cobalt plasmas is retained in the soluble fraction after either denaturation of the proteins at 100°C at pH 5.5 (8) or precipitation of the bulk of the plasma protein with 5 percent perchloric acid. Although there have been reports (9) that erythropoietin is not heat-stable, in our hands the loss of activity with this procedure is appreciable but not complete. The heat-stable, acid-soluble activity of both types of plasma may be dialyzed without marked loss of erythropoietin titer.

While these parallelisms are not conclusive evidence that the material in cobalt plasma is identical with that in anemic plasma, they suggest that both types of plasma contain erythropoietic factors with grossly similar properties (10).

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5 March 1957

Control of Arrested Fruit Growth in Tomato by Gibberellins

In recent months, several reports have shown that the gibberellins, when applied to higher plants, are effective in promoting the elongation both of dwarf mutants of corn (1) and of normal plants of several additional species (2). The gibberellins also promote the expansion of etiolated leaves (3), reverse the red-light-induced inhibition of pea internode growth (4), break the dormancy of red-light-requiring lettuce seed (5), and effectively substitute for the cold (6) requirement of biennial *Hyoscyamus*.

The afore-mentioned results suggested that the gibberellins might also be effective in alleviating the condition of arrested fruit growth and development (which is essentially a condition of dormancy) in commercial tomatoes. This condition is particularly characteristic of the fruits of the Marglobe variety grown in the field under the high light and temperature of summer or in the greenhouse in early fall at College Station, Tex. (7). The condition of "summer dormancy" in tomato in essence amounts to a very marked reduction of growth of both vegetative and reproductive structures. The leaves fold inward toward the petiole; the whole petiole and attached leaf-



Fig. 1. (Left) Marglobe tomato fruit spur with small, dormant, pollinated fruits. (Right) Spur with enlarging fruits following five applications of a 25- μ g/lit gibberellic acid spray to the sepals.

lets then fold upward toward the stem, and the internodes of the stem become progressively shorter as the season proceeds. Even though some viable pollen may be produced and fertilization may occur, the fruits remain very small (0.5 to 2.0 mm in diameter) until some external factor breaks their "dormancy." It has been shown that this summer-induced dormancy of tomato fruits can be caused by far red irradiation in the winter (8) and that cool temperatures, auxins, or red light are capable of reversing it. However, none of these methods serves as a practical means of control in the field.

Seedlings of Marglobe tomatoes were potted in individual containers on 15 Aug. 1956 and treated in October and November. The green sepals of the dormant fruits were sprayed until run-off on alternate days for a total of five sprayings with water or gibberellins (9) at 25 or 250 μ g/lit. The sprayed fruits, approximately 2 mm in diameter before spraying, were allowed to develop for 15 days following the initial spraying before the experiment was terminated.

Both 25 and 250 μ g of gibberellin per liter produced an appreciable number of enlarged fruits as compared with controls. Thus, of the 121 fruits on control plants, only nine (7 percent) had broken dormancy and grown to at least 5-mm diameter, whereas 63 of 135 (46 percent) and 30 of 128 (23 percent) of those treated with 25 and 250 μ g/lit, respectively, had increased to this size. The higher concentration appeared to be slightly toxic, for a number of young dormant fruits turned brown after application of the spray; this condition was

not apparent in either the controls or at the 25 μ g/lit level. Figure 1 shows the striking effect of gibberellins on the development of dormant tomatoes.

These results are not in agreement with the negative results on normally developing fruits reported by Marth *et al.* (2). However, it is possible that there is no basis for comparing dormant fruit and normally developing fruit. The mechanism of action of the gibberellins in this system is not known. On the basis of experiments with leaf disks conducted in this laboratory (3), it would not seem that the gibberellins replace the red light. This is more unlikely when it is considered that auxins and cool weather also break the dormancy of tomato fruits. A more plausible explanation would seem to be that all these factors affect the same biochemical pathway, but at different reaction steps or in a different manner. A full understanding of the action of the gibberellins in this system as well as in other systems reported must await further experimentation (10).

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10. This investigation was supported in part by grant No. G-1165 from the National Science Foundation to J. L. Liverman.

14 February 1957

Effect of Iodoacetate and Iodoacetamide on Oxygen Uptake of Heart Mitochondria

Iodoacetate and iodoacetamide have been used as specific inhibitors of the Embden-Meyerhof pathway of glycolysis, the site of inhibition being at the triose-phosphate dehydrogenase. Early reports (1) indicated that iodoacetate at low concentrations inhibited anaerobic glycolysis and respiration with glucose but not the oxygen uptake induced by addition of pyruvate or lactate. More recent studies (2) have shown that the oxidation of pyruvate may be reasonably sensitive to iodoacetate. A study of the

direct effects of iodoacetate and iodoacetamide on the aerobic oxidation of pyruvate and cycle intermediates by mitochondria would provide more information on their effects on respiration and give a basis for the judicious use of a particular concentration of these inhibitors to inhibit specifically the glycolytic pathway.

The preparation of the rat heart mitochondrial suspension and the manometric measurement of oxygen uptake were made according to the methods of Montgomery and Webb (3). The results are summarized in Table 1. Both inhibitors at a concentration of 1.0 mM produced distinct inhibition with all substrates, the strongest inhibition being observed in the oxidation of pyruvate and α -ketoglutarate, which may indicate the sensitivity of systems involving coenzyme A and lipoic acid. However, the lower concentrations also produced definite inhibitions which cannot be ignored in respiratory studies. It may be noted that iodoacetate was generally more effective than iodoacetamide. In order to produce complete inhibition of triose-phosphate dehydrogenase and glycolysis, concentrations of 0.2 to 0.5 mM must be used in most cases, and thus the present results indicate that a complete inhibition of glycolysis is usually accompanied with some effect on respiration (4).

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18 February 1957

Carbon-14 Activity of Some Heat-Degradation Products of Milk Containing Lactose-1-C¹⁴

The course of heat-induced lactose-protein interaction in milk has been followed with the aid of lactose-1-C¹⁴ (1). Use of labeled lactose also appeared attractive for investigation of the sugar's decomposition under these conditions. Of the many fragments known to be formed (2), formic acid, furfuryl alcohol, and maltol (3-hydroxy-2-methylpyrone-4) were evaluated in these experiments. It has been proposed that formic acid is derived from carbon atom No. 1 and furfuryl alcohol from carbon

Table 1. Levels of C¹⁴ activity found in some heat-degradation products of skim milk containing lactose-1-C¹⁴.

Compound	Activity of BaCO ₃			
	Carbon (atom/mole)	(Count/min mg)		Lactose/product C ¹⁴ ratio
		Found	Theory*	
Lactose	12	8.7		
Formic acid	1	53	104	1/0.51
Maltol	6	14	17.4	1/0.81
Furfuryl alcohol	5	0.8	20.9	1/0.04
Naphthyl urethane	16	0.0	6.5	
3,5-Dinitrobenzoate	12	0.0	8.7	

* Based on molar transfer of 1 atom of C¹⁴.

atoms 2 through 6 in the glucose moiety of lactose (3). Maltol results rather uniquely from the heat-induced interaction of reducing disaccharides with amino compounds (2). It has been detected in evaporated milk, baked cereals, bread crust, and roasted malt, among other places (4).

The three compounds in question were recovered and purified from heated (121°C for 4 hours) condensed skim milk (30 percent total solids) to which lactose-1-C¹⁴ (National Bureau of Standards) had been added. Steam distillation was used to isolate the compounds from the heated milk. Maltol and furfuryl alcohol were recovered from this distillate by ethyl ether extraction and were purified as described elsewhere (3, 5). Formic acid was recovered by neutralizing a portion of the distillate to pH 7.5 and evaporating the solution to dryness under vacuum (6). The crude formate was selectively converted to CO₂ by the method of Osburn *et al.* (7). This CO₂, samples of furfuryl alcohol and its derivatives, maltol and lactose, the latter from the unheated product, were converted to BaCO₃ (8). Radioactivity in these preparations was determined with a windowless flow gas Geiger-Müller counter and decade scaling unit.

The data thus secured (Table 1) reveal that carbon atom No. 1 of lactose is involved in the formic acid and maltol, but not in the furfuryl alcohol. A preliminary experiment yielded essentially the same findings with the exception that some activity was detected in the furfuryl alcohol (9). Further investigation of the alcohol and two carefully authenticated derivatives of it, as shown in Table 1, revealed that it had no activity.

Under the rigorous heating conditions employed in these experiments, a number of carbon sources could contribute to formate; however, carbon 1 of lactose

Table 1. Effects of iodoacetate and iodoacetamide on the mitochondrial oxidation of various substrates. The reaction medium contained 121 mM KCl, 20 mM potassium phosphate buffer (pH 6.8), 0.01 mM cytochrome *c*, 5 mM MgCl₂, 1 mM adenosine monophosphate, 0.5 mM adenosine triphosphate, and 5 mM substrate. The temperature was 37°C. The mitochondrial suspension was incubated for 10 minutes with the inhibitors in the medium, and the oxygen uptake was determined over a period of 1 hour.

Substrate	Change (%) at various concentrations		
	0.01 mM	0.10 mM	1.0 mM
<i>Iodoacetate</i>			
α -Ketoglutarate	- 6.3	-33.3	-75.6
Malate	- 7.4	-20.0	-63.9
Pyruvate + malate	- 4.3	-43.0	-85.6
Succinate	- 3.8	- 8.0	-61.2
Citrate	+ 4.6	- 8.1	-34.6
Isocitrate	+15.0	-15.3	-35.0
<i>Iodoacetamide</i>			
α -Ketoglutarate	- 6.4	-17.2	-76.3
Malate	- 1.0	-21.0	-35.3
Pyruvate + malate	- 9.4	-12.6	-79.7
Succinate	- 2.5	-17.0	-43.1
Citrate	-16.1	-14.9	-44.1
Isocitrate	-12.0	- 7.3	-29.1

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appears to be the principal origin. Theories which propose that the carbon skeletons of furfuryl alcohol and maltol of heated milk derive from carbon atoms 2 to 6 and 1 to 6, respectively, in the glucose moiety of lactose remain attractive in light of these findings (10).

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8 March 1957

Gamma Rays from Local Radioactive Sources

There is considerable interest at the present time concerning the possible effects of man-made radiations on man himself. Because one source of these radiations is of world-wide extent, the interest has also become world-wide. Although considerable literature now exists on the subject of man-made radioactive contamination, on the one hand, and on the biological effects of radiation, on the other, the actual importance of the first as far as the second is concerned has often been obscure. It is thought desirable at this time to present some independent experimental data that will allow individuals to reach their own conclusions.

As early as 1928, R. A. Millikan became interested in the gamma rays emitted by local radioactive materials in the soil and rock at various localities in order to determine the effect of these radiations on the cosmic-ray measurements in which he was primarily interested. These measurements extended from California into the Rocky Mountain area and on up to Churchill, Manitoba (1). They probably represent a unique series of measurements, since they were made before man-made contamination became widespread.

An ionization chamber measures directly the quantity of interest as far as the biological effects of gamma rays are

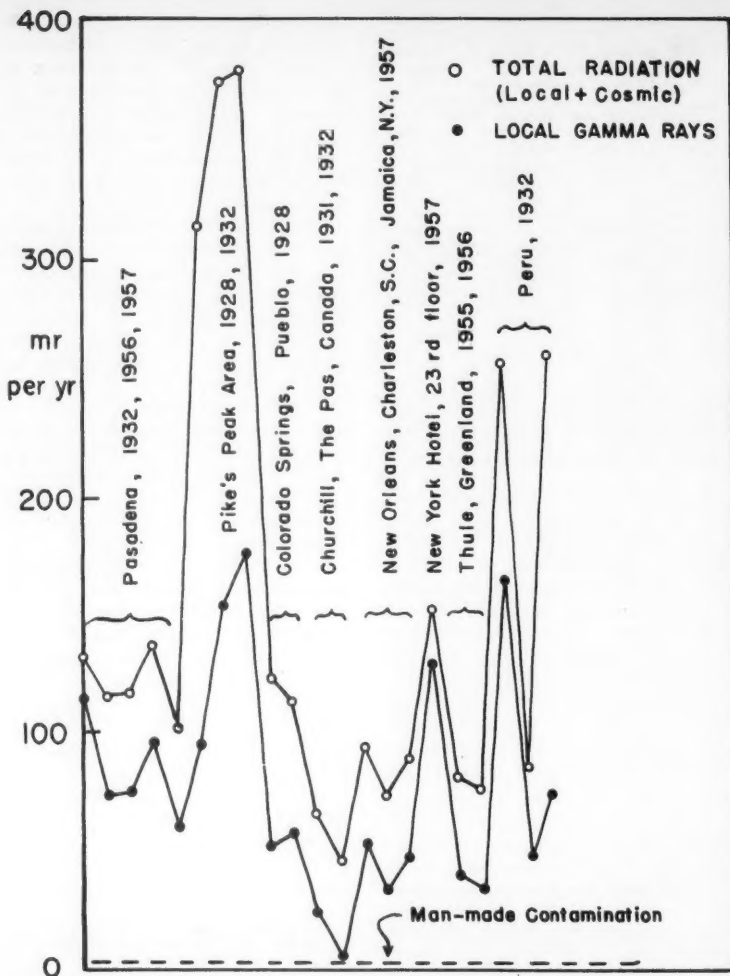


Fig. 1. "Noise level" of gamma rays and cosmic rays in the Western Hemisphere. Abscissas roughly increase with increase of distance from Pasadena. The amount of man-made contamination is taken from the National Academy of Sciences report, *Biological Effects of Atomic Radiation* (7). As is stated in that report, "... U.S. residents have, on the average, been receiving from fall-out over the past five years a dose which, if weapons testing were continued at the same rate, is estimated to produce a total 30-year dose of about 0.1 roentgen" (an average of 3 mr per year).

concerned, and this is the instrument here employed. One of the instruments Millikan made and calibrated is still in good condition after 26 years and is very convenient to use. A recent redetermination of the absolute value of the calibration (2) agrees with Millikan's value to 0.3 percent. In this survey, Millikan's instrument has been used for some of the measurements, and a more modern ionization chamber (3) for others. The two give essentially the same answer. Both were used unshielded in the measurements reported here.

In Fig. 1, most of the values taken during the years have been entered. The ordinates are in milliroentgens (mr) per year. To convert into ion pairs per cubic

centimeter, per second in 1 atmosphere of air, divide the ordinates by 15. The various stations are plotted as abscissas with the same increment from one to the other. Roughly, the stations get farther from Pasadena with increase in abscissa. The chief reason for plotting in this manner was to bring out the variability of radioactivity from one station and region to another.

Measurements were made of the total radiation at a given station; then the known contribution from cosmic rays (4) was subtracted to get the effect of the gamma rays from local radiation only.

In the Rocky Mountain region, the local radiation is high, presumably because of the granite, which is known to

contain something like 4 g of uranium and 15 g of thorium per ton (5). In Peru, the radioactivity of the coastal plain is much the same as that of the Mississippi region near New Orleans. The local radiation at an elevation of 15,000 feet in southern Peru is only slightly higher than that of the soils of the coastal plain. Most of the houses of Arequipa are built of a light rock called "tuva" which is of volcanic origin. This rock is 3 or 4 times as radioactive as the soil near Lima.

There is considerable variability of local radiation in some cases over small distances. According to Millikan (6), the gamma rays on the Laurentian Shield near Churchill, Manitoba, give 0.8 ion $\text{cm}^{-3} \text{ sec}^{-1} \text{ atm}^{-1}$ of air, or 12 mr yr^{-1} , while nearby the intensity on the glacial sand is 35 mr yr^{-1} . It may be of interest that the radioactivity on the ice cap near Thule, Greenland, in August 1956 was less than 2 percent of cosmic rays.

A wooden building forms some shielding from local gamma rays. In my own house, the gamma rays on the first floor give 60 mr yr^{-1} , while in the back yard the intensity is 95 mr yr^{-1} . The rather high value of 130 mr yr^{-1} on the 23rd floor of a major hotel in New York is presumably owing to the material from which the building is constructed.

The root mean square "noise" level of the total radiation given in Fig. 1 is about 160 mr yr^{-1} . To find the effect on the population, the local radiation must be weighted according to the population. This has not been done. Perhaps it is fortunate that most of the population of the country lives where the radiations due to cosmic rays and local radiations are relatively low.

The dashed line near the bottom of Fig. 1 is taken from the Summary Reports on the Biological Effects of Atomic Radiation of the National Academy of Sciences (7). Even though there is some error in the determination of this value, as well as considerable variation of fall-out over the country, it is quite evident that man-made contamination is still small compared with the changes in radiation from one part of the country to another.

The data presented here are for gamma rays only, since the walls of the ionization chamber are too thick for beta rays to penetrate, either from naturally occurring or artificially produced radioactive materials.

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15 March 1957

New Method for Detection of Human Poliomyelitis Antibodies

We have reported that if the lower edge of a strip of filter paper is placed in a suspension of a virus, the virus rises on the paper and becomes distributed in a regular, reproducible manner (1). The experiments described in this report show clearly that the upward spread of virus is decreased when serum containing specific antibody is placed in a band across the filter paper (2). Serum without antibody does not exhibit this effect. The "blocking" action of specific antibody has been observed with polioviruses and with six other viruses. The "blocking" of polioviruses by human serums which contain neutralizing antibody is type specific.

Whatman filter paper No. 3 is cut into strips 12 by 1.75 cm. Each strip is marked off by light pencil lines into 1-cm spaces (numbered 1 to 12), suspended from a rubber stopper, and auto-

claved. Poliovirus cultivated in monkey kidney tissue is diluted to a concentration of 100 TCD₅₀ per milliliter in 0.85-percent NaCl containing 10 percent bouillon broth. Thirty milliliters of the diluted virus is placed in a sterile bottle surrounded by ice. The serum to be tested (previously inactivated at 56°C) is then distributed evenly over spaces 3 and 4 of the filter paper. The paper is placed in the bottle containing the virus with only the lower half of space 1 below the surface of the virus suspension (see diagram of apparatus, Fig. 1). After 1 hour the strips of paper are removed, and each paper space is cut off and placed in a monkey kidney tissue-culture tube. Tissue culture tubes are incubated and observed for virus cytopathogenic effects in the usual manner. Neutralizing antibody titers of the serums used in the paper tests are determined by standard tissue culture methods.

Fifty-two successive tests (104 paper strips) with 14 human serums have given virtually identical results. Virus was detected by tissue culture on every wet space of every paper strip on which serum containing no antibody had been placed. In contrast, no virus was found above space 6 on any of the paper strips that were treated with serum which contained type-specific poliovirus antibody. No virus was detected above space 4 in the vast majority of such strips. Figure 1 shows examples of typical results. In

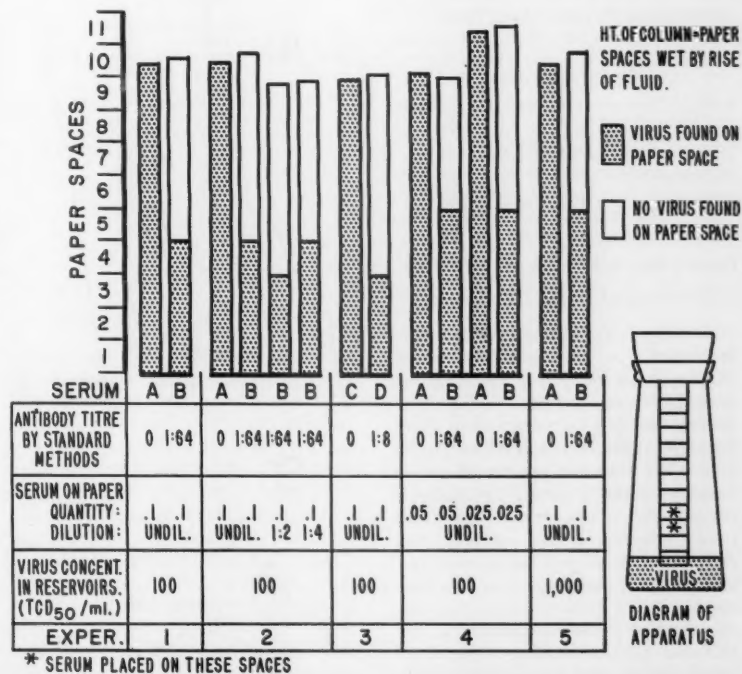


Fig. 1. Sample experiments showing that serum which contains type-specific antibody decreases the extent of the spread of type 2 poliomyelitis virus on filter paper.

experiment 1, serum A contains no neutralizing poliovirus antibody. When placed on filter paper, it did not prevent the rise of virus; all of the ten spaces which became wet were shown to contain virus when placed in tissue culture. In contrast, no virus could be detected above space 4 on the paper that had been treated with serum B, which had a neutralizing antibody titer of 1/64. Experiment 2 shows that the "blocking" action is still present when serum B is diluted. Experiment 4 shows that the "blocking" action was demonstrable with as little as 0.025 ml of serum B, a quantity readily obtainable by finger puncture.

For practical purposes, the placing of a single paper space into a single tissue-culture tube gave correct information regarding the presence or absence of poliovirus antibody. This is true of space 7, for example, in each of the 52 successive tests performed. When a pool of types 1, 2, and 3 polioviruses is tested against a serum, only that type against which there is no specific antibody in the serum can be detected high on the paper.

This method requires only one tissue-culture tube and a quantity of blood which is small enough to be obtained readily by finger puncture. The method may be, therefore, a valuable screening test for distinguishing immune from non-immune persons in a poliomyelitis vaccination program.

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26 February 1957

Concurrent Schedules of Reinforcement in the Chimpanzee

This report (1) describes a technique for establishing two behavioral repertoires simultaneously in a single animal subject. This was done by training chimpanzees that had been reduced to about 80 percent of their normal weight to press either or both of two keys that were mounted 6 inches apart. The animals pressed the keys because occasional presses operated a food magazine that delivered 40-kcal. portions of food (reinforcement). The schedule by which the key presses are reinforced determines the rate at which the animal presses the key. Different rates of pressing were established on the two keys by using two schedules of operation of the food magazine (schedule of reinforcement). The

schedule of reinforcement on the right key was designed to generate a high, sustained rate of pressing, whereas the schedule on the left key was designed to generate a low rate. The amount of independence between the performances on the two keys could be assessed because of the contrasting rates of key pressing. Any "confusion" between the two keys would result in high rates of pressing on the key normally producing low rates, and vice versa.

The chimpanzee, with its semierect posture and good hand dexterity, was of special interest for this type of experiment because it could operate the two keys simultaneously. Most subprimates would have to alternate between the two keys. The time spent changing back and forth between the keys would interfere with the characteristic performance under the single schedule of reinforcement.

The specific experimental conditions were similar to those already described for the pigeon (2). The experiment began with only one key and a schedule in which the magazine operated after a fixed number of responses. This is called a fixed-ratio schedule: "ratio" refers to the ratio of presses to reinforcements (3). This schedule generates a high, sustained rate of responding except when the number of responses required for reinforcement is large. Then, a pause de-

velops following each reinforcement; but when the animal again starts pressing the key, it begins immediately at the prevailing high rate. In general, moderate rates or smooth transitions from one rate to another are absent under this schedule. If the animal operates the key at all, it tends to do so at the prevailing high rate.

After a stable performance had developed on the first key, a second key was added 6 inches to the left. Presses of the second key were reinforced on the basis of elapsed time rather than number of presses. The first press after a given interval operated the magazine; but the interval varied from reinforcement to reinforcement, ranging from 3 seconds to 8 minutes, with a mean value of 4 minutes. This schedule, which is called variable-interval reinforcement, produces a moderate rate of responding (3). The random spacing of the reinforcements produces a constant rate of responding and prevents pauses from developing after reinforcements. Changes in rate, when they do occur, seldom are abrupt, as they are in the fixed-ratio schedule. The variable-interval performance stabilized quickly. The number of responses required for reinforcement on the right (fixed-ratio) key was then increased to 120 over 27 experimental sessions. The larger number of responses required for

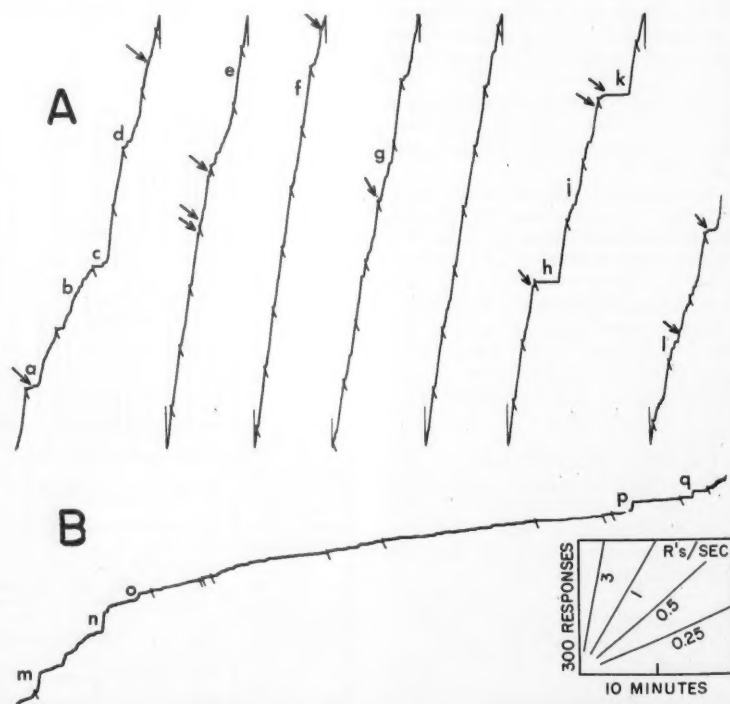


Fig. 1. Cumulative curves of responses on the two keys. Record A, responses on the right-hand key; reinforcement was on a fixed-ratio schedule. Record B, responses on the left-hand key; reinforcement was on a variable-interval schedule.

reinforcement on the fixed-ratio key provided a longer period of time in which simultaneous presses of the variable-interval key could occur.

Figure 1 is a graphic record of a complete daily performance. Responses cumulated against time give a curve whose slope depicts the moment-to-moment changes in the rate of pressing the key. Presses of the right key are recorded in the top curve (record A), and presses of the left key are recorded in the bottom curve (record B). The discontinuities in the top curve represent the resetting of the recorder pen when it reached the limit of its excursion. In order to give more compact presentation, the parts of the curve in record A are not pieced together. Because both records were taken simultaneously, a given distance along the abscissa represents the same point in time for both curves. The insert in the lower right-hand corner of the figure shows the coordinates and scale of the curves. The four slope lines in the insert indicate reference values for various rates of responding in responses per second. Reinforcements are marked by the short marks oblique to the curve. The lower-case letters above the curves are used to refer to details of the curve.

For the most part, the performances of the animal on both keys are similar to those that would develop singly without interference from the behavior on another key. Presses of the right key (top curve) tend to be sustained at 3 to 4 responses per second, while presses of the left key (bottom curve) occur at about 0.1 per second. The simultaneous reinforcement on the two schedules of reinforcement, however, produced deviations from performances that would emerge if these schedules of reinforcement were arranged singly. Major deviations from a normal fixed-ratio performance occur as low rates of responding, as in the segments marked *a* and *b*. The rate of pressing accelerates gradually in the segments marked *c* and *d*, instead of the normal abrupt shift from a pause to a high rate as in the segments marked *h* and *k*; and bursts of responding separated by brief pauses occur, as in the segments marked *g*, *i*, and *l*, where high rates of pressing are sustained, reaching values as high as six presses per second for brief periods. These performances may be compared with the segments between *e* and *f*, which show a normal fixed-ratio performance. Major deviations from a normal performance on the variable-interval schedule occur as brief bursts of responding at high rates, as at *m*, *n*, *o*, *p*, and *q*. These can be compared with the low, constant rate of responding that prevailed for most of the session, as in the part of the curve between *o* and *p*.

For the most part, the chimpanzee

used its left hand on the left key and its right hand on the right key. In many instances, it pressed both keys simultaneously, despite the large difference in the rate of pressing on the two keys. Approximately one-third of the responses on the variable-interval key coincided with presses of the fixed-ratio key. Food that was received from reinforcement of responses on the left key was taken from the magazine and eaten while the animal continued to operate the right key in the characteristic manner. The extent of the disturbance can be seen by examining the top curve in the vicinity of the small arrows, which indicate the exact point of food delivery occurring because of reinforcement of responses on the other key.

The technique used in this experiment demonstrates a method which could be used for studying bilateral independence (as, for example, the hand independence exhibited by a pianist when his left and right hands play at different tempos) in an animal subject. The ability to maintain two different kinds of behavior simultaneously could also have application in the study of emotional side effects of some psychological variables. For example, the performance on one key could be used as a baseline for the emotional side effects of a change in the schedule of reinforcement on a second key.

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25 February 1957

Fat Weight and

Fat Placement in the Female

The measurement of body fat relates to two distinct problems, the amount of fat (fat weight) and the distribution of fat (fat placement). Although considerable information has been gathered on fat weight and fat placement in the male, comparable data on the female are meager. One set of estimates of body fat for adult females was of necessity based on skin-fold measurements of English outpatients and extrapolations from body-fat determinations made on guinea pigs (1).

Standardized soft tissue x-rays were taken on 107 healthy, adult, American-born women, aged 20 to 60 years, with a mean age of 39. Comparable roent-

Table 1. Comparison of subcutaneous fat thicknesses in adult males and females. The sex difference in fat thickness is significant beyond $p = 0.01$ except for the deltoid pocket and iliac crest.

Fat measurement	Median values (mm)		Fat ratio female/male
	107 females	81 males	
Lateral arm	6.2	4.4	1.41
Medial arm	6.6	3.5	1.89
Deltoid pocket	17.8	18.0	0.99
Iliac crest	19.0	19.2	0.99
Trochanteric	28.1	15.6	1.80
Lateral leg	7.4	4.8	1.54
Medial leg	10.9	6.0	1.81
Anterior leg	4.1	2.6	1.58
Posterior leg	13.0	7.0	1.86
Stature (cm)	162.5	176.5	
Weight (kg)	58.3	76.4	

genograms were made on 81 clinically healthy adult males, of equal age range and of a mean age of 40 years. The two groups were drawn from the same population. Fat-shadow measurements were made at the following sites: lateral arm, medial arm, deltoid "pocket," iliac crest, mid-trochanteric, lateral leg, medial leg, anterior leg, and posterior leg (2). All distributions involving fat were highly skewed: median rather than mean values are therefore reported.

The women exceeded the men in seven out of nine fat-plus-skin measurements, with female/male ratios for subcutaneous fat up to 1.89. The actual differences, which were all significant at $p = 0.01$ or better, ranged up to 13.5 mm for trochanteric fat (see Table 1). However, in two thicknesses (deltoid "pocket" and iliac crest) sexual dimorphism was not complete; here male fat thicknesses were absolutely but not significantly greater. This confirms other evidence that for particular subcutaneous fat sites there may be a reversal of the usual trend (3).

From the intercorrelation matrices, trochanteric fat emerged as the best single predictor of total fat for adult males, as previously reported (4); iliac crest fat had the greatest communality with other fat sites for the female. The weight of fat, fat values, and constants appropriate for each sex were then estimated, on an individual basis, using the prediction formula (5)

$$y = r \frac{\sigma_y}{\sigma_x} x$$

The estimated median weight of fat for the females was 13.7 kg, not markedly greater than the median of 12.6 kg for the males. Estimates based on other central fat sites were very similar.

While males and females did not differ notably in the weight of fat, relative to the total weight the sex difference was marked. The percentage of fat was estimated as 23.7 for the females and 16.8 for the males; on the basis of these figures, the females were approximately half again as fat as the males. Again, since female subcutaneous fat thicknesses were generally greater, but total fat was not notably different, it follows that the sex difference in the proportion of outer and inner fat is considerable. Women carry more fat on and less in their smaller frames.

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8 March 1957

Chemical Protection against X-radiation Death in Primates: a Preliminary Report

The ability of a wide range of biochemically active compounds to offer protection to the animal organism against x-radiation death has prompted a great deal of investigation in this direction within the past few years. Such compounds as β -mercaptoethylamine, 2,3-dimercaptopropanol, S2, β -aminoethylisothiuronium \cdot Br \cdot HBr (AET), and numerous others have shown a remarkable degree of protection in mice (1).

Outstanding among these compounds is AET. This drug is known to provide 100-percent survival at 30 days against a dose of whole body x-radiation which is 100-percent lethal in untreated mice. It has also been shown to offer more effective protection to mice than does β -mercaptoethylamine on an equimolar basis (2).

Considering the increased interest in the prevention of radiation death and the high degree of protection afforded the lower animals by AET, it seemed mandatory that further studies should be carried out in primates. This is a preliminary report (3) of work in progress to determine the protective effect of this drug in the monkey.

AET in doses ranging from 100 to 400 mg/kg of body weight has been given intraperitoneally to *Macaca mulatta* monkeys prior to the administration of a dose

of whole-body x-radiation. At dose levels above 250 mg/kg, the toxicity of the drug is prohibitive when it is administered intraperitoneally as a single dose. However, the monkey can readily withstand 250 mg/kg in a single dose, if lower doses are administered over a period of a few days, and the doses are gradually increased from 100 to 250 mg/kg. A Westinghouse Quadrocondex 240-kv therapy machine with 1.0 mm Al plus 1.0 mm Cu filters was used for radiating the monkeys. At 240 kv, 15 ma, and a half-value layer (HVL) of 2.0 mm Cu, the machine delivers 13.25 r/min at 100-cm target distance. The animals were secured in a wooden chair which was rotated 4 times per minute in the x-ray beam.

Paterson (4), using *M. mulatta*, has found that 100 percent of the animals die as a result of 600 r of whole-body x-radiation administered in a single dose. The dose level of 650 r employed in this experiment, therefore, appears to be well above the LD_{100} and has resulted in the death of 100 percent of the untreated radiated control monkeys in this laboratory.

One animal was injected intraperitoneally on successive days with the following doses of AET: 100, 150, and 200 mg/kg of body weight. Three days after the 200-mg injection, the animal was given 250 mg/kg and was immediately radiated with 650 r of whole-body x-radiation. This animal is surviving at 280 days postirradiation and is apparently normal. A second monkey was injected intraperitoneally with 100 mg of AET per kilogram of body weight and 4 days later was given 150 mg/kg. Two days after the 150-mg injection, the animal received 200 mg/kg and was immediately radiated with 650 r of whole body x-radiation. This animal was surviving and apparently normal at 124 days when it was sacrificed for histological examination.

Peripheral blood studies of the two animals were indicative of the protective ability of the drug. By the fourth day postirradiation in both animals, the number of circulating blood cells was greatly reduced and remained at a low level until the 18th day. On the 18th day postirradiation, the circulating reticulocytes showed a dramatic steep increase in number, with an increase also in the number of circulating leucocytes. The increase in reticulocytes was followed in 4 to 6 days by a return of the hematocrit toward normal. The influx of reticulocytes began to subside by the 30th to 32nd days, and the entire peripheral blood picture had returned to normal by 65 days. In neither case did the peripheral blood picture reach the low levels observed in unprotected control animals that were irradiated at the same dose level.

These preliminary studies indicate that AET in doses of 200 to 250 mg/kg of body weight is capable of protecting the primate from x-radiation death when it is administered prior to irradiation. Expansion of this study is in progress both with regard to the toxicity of the drug and to its radioprotective ability.

Note added in proof. Since this paper was submitted, four monkeys have reached 30-day survival after having received 150 mg of AET per kilogram of body weight in a single dose prior to administration of 650 r of whole-body x-radiation. Peripheral blood studies of these four animals bear out the findings up to 30 days described in this report.

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25 February 1957

Control of Certain Forms of Zooplankton in Mass Algal Cultures

The most common difficulty experienced in growing phytoplankton on a large scale, in tanks of several-thousand-liter capacity, is the invasion of the cultures by various forms of zooplankton. In our cultures (1), the common offenders are crustaceans, especially the members of the subclass Copepoda. Upon entering cultures of such forms as *Chlorella*, these pests rapidly multiply to such an extent that they consume most of the plant cells, rendering the cultures worthless.

We have tried a number of measures to prevent contamination with zooplankton of open-air algal cultures or to free the cultures from these animals after they become established. However, this was usually impossible to achieve because some eggs, juveniles, or adults were either left behind or quickly re-introduced. Other workers (2) have reported contamination in their open-air algal cultures and also that attempts to exterminate the undesirable forms were practically unsuccessful.

During our recent efforts to develop chemical methods for controlling enemies of oysters and clams (3), we found several substances that are highly toxic to many aquatic arthropods, such as green and mud crabs, prawns, shrimps, and so forth, which are direct or indirect enemies of shellfish (4). We decided to try some of these substances to exterminate the crustaceans so often prevalent in algal cultures. Those selected were O,O-dimethyl-S-(4-oxo-benzotriazino-3-methyl) phosphorodithioate, O,O-dimethyl-2,2,2-trichloro-1-hydroxyethyl phosphonate, O,O-diethyl-O-p-nitrophenyl thiophosphate, γ -benzene hexachloride, and 2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane, which are used in the manufacture of insecticides, and are known under the trade names of Guthion, Dipterex, Parathion, Lindane and DDT, respectively.

The experiments were conducted as follows: To each vessel containing 1000 ml of phytoplankton culture, consisting largely of *Chlorella*, *Chlamydomonas*, and other common forms, and also containing large numbers of crustaceans, chiefly copepods, solutions of the aforementioned chemicals were added to create concentrations of 1.0, 0.1, 0.05, and 0.01 ppm. In a 1.0-ppm solution of Guthion, all crustaceans were killed within 2 hours at room temperature. With a similar concentration of Dipterex, Parathion, Lindane, or DDT, this was achieved at the end of 8, 20, 22 and 46 hours, respectively. Complete mortality was also caused by 0.05 ppm of Guthion and Lindane at the end of 20 and 53 hours, respectively, while no appreciable mortality occurred in solutions of 0.01 ppm.

An aim of these experiments was to find a chemical which, when added to the infested algal culture, would kill the invaders but soon lose its toxicity. Thus, it would exert no ill effect on the mollusks or other forms for which we use our algal cultures as food. For this, the stability of the compounds mentioned was tested in concentrations of 1.0 and 0.1 ppm in pure sea water and in dense *Chlorella* cultures. Both solutions of Guthion were as toxic to copepods at the end of 5 days as they were at the initial testing. Solutions of Lindane and DDT also showed no loss of toxicity.

Dipterex, on the other hand, indicated that it has the desirable characteristic of losing its toxicity soon after it is added to algal cultures. Under this condition, it lost its lethal power after 3 days, whereas, when it was dissolved in pure sea water, it was still lethal to the crustaceans even after 20 days. Since Dipterex is relatively unstable in strongly alkaline media, it is probable that it disintegrated rapidly in algal cultures because the photosynthetic activities increased the pH to a high level. It may be, however,

that the decrease in toxicity of the Dipterex was the result of adsorption of the chemical by the large quantities of particulate organic matter present in the cultures. Commercial TEPP, containing 40 percent of tetraethyl pyrophosphate, which we found highly toxic to copepods but which, in solution, completely detoxifies within a few days, may sometimes be substituted for Dipterex.

During these experiments, our large culture tank, containing approximately 6000 liters of phytoplankton, became heavily infested with copepods. This gave us an opportunity to try the control measure on a large scale. A solution of Dipterex was added to the tank to make a concentration of 1.0 ppm. By the end of the second day, no living crustaceans remained in the tank.

Since our phytoplankton cultures are grown principally to provide food for mollusks and their larvae, it was necessary to determine the effect of the chemicals on the algal cultures themselves and also on the mollusks. Experiments showed that the algal cultures were not unfavorably affected even when the concentration of the chemicals in them was as high as 1.0 ppm.

In feeding the mollusks, one volume of our algal cultures is usually diluted with about 50 volumes of sea water. Therefore, the strongest concentration of the chemicals to which the mollusks or their larvae would be exposed would be approximately 1 part in 50 million. However, to be certain that exposure to the chemicals was relatively safe for the mollusks, we tried the same concentrations as those used to exterminate crustaceans.

Adult oysters, *Crassostrea virginica*, and mussels, *Mytilus edulis*, were kept for 2 days at room temperature in solutions of 1.0 and 0.1 ppm of Guthion, Dipterex, Parathion, Lindane, and DDT. In all these solutions the oysters behaved normally. Later, the oysters were returned to running water and kept under observation. Their behavior remained normal.

The mussels pumped continuously in both concentrations of Dipterex, Lindane, and DDT. However, in a 1.0-ppm solution of Guthion and Parathion, they pumped less actively than they did in 0.1 ppm. When they were returned to sea water, however, all were equally active and normal in their behavior.

In another series of experiments, several species of adult and juvenile bivalves, including *Crassostrea virginica*, *C. rhizophora*, *Ostrea edulis*, *Venus mercenaria* and *Mytilus edulis*, were kept for 1 month in running water to which a Dipterex-treated culture of *Chlorella* was continuously added. The ratio of the volume of *Chlorella* culture to sea water was approximately 1/50. During the period of exposure, all groups of mol-

lusks behaved normally, fed well, grew, and showed no unusual mortality.

The effects of the chemicals on the survival and growth of oyster larvae were ascertained by subjecting young, straight-hinged larvae, 2 days after fertilization, to solutions of 1 part of a chemical in 1, 20, and 40 million parts of sea water, thus creating concentrations of 1.0, 0.05, and 0.025 ppm. Observations on larvae subjected to these concentrations were continued for 14 days (5).

Larvae kept in 1.0 ppm of DDT all died within 4 days; in 0.05 ppm, the growth was almost completely stopped, and even in 0.025 ppm, the larvae did not grow well.

Larvae kept in concentrations of 1.0 ppm of Dipterex, Parathion, or Lindane did not suffer greater mortality than did the controls, but their growth was retarded. At the two lower concentrations, however, the larvae did not differ significantly in size from the controls.

The most promising results were obtained with Guthion. Even at a concentration of 1.0 ppm, it caused no appreciable mortality or retardation of growth of oyster larvae. Larvae kept in 0.05 ppm of Guthion actually grew faster than did those in untreated cultures.

The results of these experiments indicate that chemical control of crustaceans should greatly simplify maintenance of open-air cultures of phytoplankton. Some of the chemicals should be especially helpful in controlling crustaceans in large tanks and in small natural bodies of water intended for use as controlled sources of foods in our work on utilization of salt-water ponds for shellfish culture (6). It is believed that modifications of this method can be effectively employed to help grow *Chlorella* as a source of protein to be utilized in agriculture or by human beings, and also to control a copepod of the genus *Mytilicola*, which is a dangerous intestinal parasite affecting several species of oysters and mussels.

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18 February 1957

Book Reviews

Franklin and Newton. An inquiry into speculative Newtonian experimental science and Franklin's work in electricity as an example thereof. I. Bernard Cohen. American Philosophical Society, Philadelphia, 1956. 657 pp. \$6.

The appearance of I. B. Cohen's *Franklin and Newton* is an event of considerable importance in the history of science. Few works of comparable stature have been produced in the history of science by an American historian.

Cohen has, with this volume, demonstrated the detailed and extraordinary influence of Newton's *Opticks* on the speculative and experimental sides of 18th-century science. Few historians have realized that Franklin was, in any major respect, the heir of Newton, since "Newtonianism" is commonly equated with the mathematical mechanics of large bodies. It is the contribution of this volume to show in considerable detail that "Newtonianism," for the scientist of the 18th century, was much more the speculations and experiments of the *Opticks* than the formal mechanics of the *Mathematical Principles*. That is to say, the "Newtonianism" of the *Opticks* became the starting point in the 18th century for a rich speculative and experimental investigation of the electric, thermal, chemical, optical, and certain physical properties of bodies. "The *Opticks* provided a mechanical basis for understanding the phenomena of matter in the great tradition of Bacon and Boyle and it was appreciated as such by those who upheld the latter tradition," such as Diderot, Richard Bentley, and numerous others. The popularity of the *Opticks* rested on a number of factors: its nonmathematical character, its free use of hypothesis and speculation, its "special appeal to those physical scientists who were attempting to construct physical rather than mathematical theories that might explain (coordinate and predict) experimental phenomena in such fields as electricity, heat, chemistry, animal physiology."

In describing the "Newtonianism" of the 18th century, Cohen has gone far beyond a literal interpretation of the title, *Franklin and Newton*, for he ex-

plains at length the rise of electricity as a Newtonian science prior to Franklin and also the consequential reception of Franklin's theory after his time. Furthermore, Cohen has investigated and presented numerous examples of Newtonian experimental and speculative science between his two terminal masters. Thus, he examines for us the "Newtonian" views of Boerhaave, s'Gravesande, Desaguliers, Gauger, and Hales.

We are not to think, however, that Cohen slights the two central figures themselves in favor of their influence, for he has given us stimulating chapters on "Franklin's scientific reputation" and on "The scientific personality of Franklin and Newton" as well as a fairly detailed study of the scientific achievements of these two distinguished men of science. His epitomization of the contrasting personality of these two figures is neat: "It would be difficult to conceive two personality types as different as Franklin and Newton. One is a happy extrovert, with a wife and three children, who craved the company of women and was gregarious and self-assured. The other was a tortured introvert, who remained a bachelor all of his life, and had—at the height of his powers—what we would call today a 'nervous breakdown.'" Cohen goes on to provide us with a keen analysis of the effect of the personalities of these two men on the way in which they worked and lived.

The volume is concluded by two interesting appendixes. The first deals with the varied way in which Newton used the word *hypothesis*, in connection with the controversy over the celebrated phrase *Hypotheses non fingo*. It is shown that nine different meanings or shades of meaning were given to the word in different contexts: a system of the world, a mathematical premise, a nonproved mathematical proposition, a philosophic or physical premise, an unproved physical proposition, a contrary-to-fact condition, a mechanism to explain laws or phenomena, a "philosophic romance," and axioms and postulates. The second appendix is concerned with originality in scientific discovery, particularly with regard to Franklin's concept of electric fluid. Cohen's conclusion is that "Franklin's originality did not consist in invent-

ing out of whole cloth the idea of an electric matter so much as to give the idea the needed precision, to see the implication of a conservation principle, and to apply this concept in strikingly new ways." The appendixes are followed by a detailed bibliography of almost 50 pages.

Thanks must certainly be given to the American Philosophical Society for the fine physical appearance of this volume, both with regard to type and to illustration. I have only one criticism in regard to the makeup of the book. The notes that cite sources are at the end of each chapter but with title in a shortened form. Hence, one has to look further to the bibliography for the rest of the citation. This is a minor fault to be sure, and I certainly want to leave the prospective reader—historian and scientist alike—with the assurance that he has a rewarding experience ahead of him.

MARSHALL CLAGETT

University of Wisconsin

The Biochemistry of Vitamin B₁₂. A symposium held at the London School of Hygiene and Tropical Medicine on 19 Feb. 1955. Biochemical Society Symposia No. 13. R. T. Williams, Ed. Cambridge University Press, New York, 1955. 123 pp. Illus. \$3.75.

In the eight chapters of *The Biochemistry of Vitamin B₁₂* are concisely discussed the isolation and chemistry of vitamin B₁₂ and related nutritional factors; the methods of measuring vitamin B₁₂; the absorption and excretion of vitamin B₁₂ in man, together with the role of intrinsic factor; and the metabolic functions of vitamin B₁₂ in animal and microorganisms. Because of the rapid advances made in this field of study since the book was published, the information provided in these well-written chapters is no longer complete. For example, the complete chemical structure of vitamin B₁₂ is now postulated, interesting data on the hitherto not recognized route of excretion of B₁₂ in man have been reported, the role of intrinsic factor is more fully understood, and chemical substances capable of enhancing the absorption of vitamin B₁₂ by nonpernicious anemia patients have been discovered. In like manner, the physiological functions of vitamin B₁₂ are now better understood. This fact merely shows the intense interest of many investigators in this fascinating field. However, this book does provide basic information up to 1955.

BACON F. CHOW

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General Genetics. M. J. Sirks. Nijhoff, The Hague, 1956. 628 pp. Illus. Gld. 35.

This English edition of Sirks' *General Genetics*, first published in Dutch in 1922, emphasizes the historical aspects of the subject. In this respect it will serve as a useful reference book, especially to the work prior to 1940.

In the hands of Sirks and his translators, Jan Weijer and D. Weijer-Tolmie, however, this approach does not lend itself well to an exposition of the subject. The book appears to have accumulated information through the five Dutch editions and the present English one without critical evaluation or successful integration of the material so brought together.

An example will illustrate. Meiosis is nowhere clearly described. The old argument of pre- and postreduction is treated at some length before any attempt is made to relate it to what is currently known about meiosis and crossing over. In this review of material of purely historical interest, the following statements appear: "Classic contributions to this very important problem have been given by Gregoire (1905, 1910). Unfortunately his studies in this sphere are almost forgotten today." If one is not told what these classic contributions were or why they are important, it is not at all obvious why they are mentioned. Finally, Knapp is cited for the now generally accepted view that postreduction (second division segregation) is a result of crossing over between the locus concerned and the centromere. The earlier work that led to this interpretation (Bridges and Anderson, on *Drosophila* triploids; Anderson and others on attached-X chromosomes; and Lindgren on *Neurospora*) is not mentioned or cited in the bibliography.

The mechanism of crossing over is treated in a confusing way, with no clear statement about the importance of the question of randomness or nonrandomness with which strands participate in crossing over at a given level.

Figure 54 in the book, a graphic representation of the relation of crossing over to temperature in *Drosophila*, taken from Plough, shows a maximum at 13°C. Twenty years ago, H. F. Smith [*Nature* 138, 329 (1936)] pointed out that the original data do not show the 13° maximum—that an error was made in correcting for control values.

Important concepts are sometimes stated carelessly. In discussing the statistical evaluation of observed deviations from expected genetic ratios, it is said that a ratio of deviation to standard error of less than 1.5 "proves an absolutely normal course of segregation." Incidentally, the ratio of deviation to

standard error is called "probable error," a usage unfamiliar to me.

An attempt has been made to bring the book up to date in the translation. This must have been done hurriedly or carelessly, for there are several important omissions. Lederberg's important work on bacterial genetics is barely mentioned. The phenomenon of transformation is briefly considered, but no reference is made to the illuminating findings of Hotchkiss or of Ephrussi-Taylor. Bacterial viruses have perhaps contributed more to genetics in the decade just past than have any other organisms. They go unmentioned. The Watson-Crick structure of deoxyribonucleic acid is not referred to. Some of these omissions, particularly the latter, might be excused on the ground that they were announced too late to be included. However, mention is made of a paper published in 1954 by Weijer, one of the translators, a year after appearance of the Watson and Crick paper on deoxyribonucleic acid structure. Incidentally, a transposition in the bibliography gives Weijer's paper the date 1945.

Because of its inclusion of so much material of historical interest, *General Genetics* may be useful as a reference. It cannot be recommended as a well-organized, clearly written, and accurate account of the principles of genetics as they are understood today.

G. W. BEADLE

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Etude Radioanatomique de l'Os Temporal. M. Juster and H. Fischgold. Masson, Paris, 1955. 102 pp. Illus.

Anatomical structure approaches its peak of complexity in the interior of the temporal bone, which is so aptly called "the labyrinth." The authors of *Etude Radioanatomique de l'Os Temporal*, M. Juster and H. Fischgold, have made a unique study of this bone by making roentgenograms of macroscopic serial sections taken in the three planes most frequently employed in radiotology. These dry bone sections, 3 millimeters in thickness, were x-rayed with 2× enlargements, thus bringing obscure structures, such as the aqueducts, into greater prominence. By viewing the individual sections, one overcomes the initial problem of superimposition and is able to interpret the temporal area in conventional roentgenograms of the skull with greater accuracy. In addition to the serial sections, the authors also present x-ray studies of the isolated bony labyrinth, the ossicles, and facial canal.

Each enlarged x-ray picture is accompanied by a labeled diagram of equal

size, which greatly facilitates the interpretation and identification of the numerous anatomical structures. Finally, the authors have provided a brief text description of the radiographic structures of the temporal bone. This book should prove to be a great aid to otologists and others in the study of the ear and temporal area.

Structure is the basis of all function, both normal and pathological, and the authors have provided a means of elucidating the anatomy of a very important but difficult region of the human body. Further study and greater magnification of these radiographic sections may provide a means for earlier detection of otosclerosis and other ear diseases which are accompanied by structural changes in the temporal bone.

M. WHARTON YOUNG

Howard University College of Medicine

Organic Analysis. vol. III. John Mitchell, Jr., I. M. Kolthoff, E. S. Proskauer, and A. Weissberger, Eds. Interscience, New York, 1956. 546 pp. Illus. \$11.50.

Each volume of the Interscience *Organic Analysis* series is a collection of monographs on the determination of important functional groups and on modern techniques that are used in organic analysis. The third volume is more than 70 pages larger than the longest of the previous volumes, yet it contains monographs on only six subjects, as contrasted with nine in each of the earlier volumes. These statistics reflect an improvement in that each subject is now considered broadly, the treatment is more uniformly thorough, and all of the sections include explicit operational directions for selected analytic methods.

Each monograph is prefaced by a simple introduction, addressed to the reader who is not a specialist. The introductions are noteworthy in the way they undertake to orient the reader so that he will be able to make personal use of the information that follows. For example, the fourth monograph begins with a simple and lucid definition of olefinic unsaturation and its chemical characteristics and sets up, specifically, the chemical conditions that the analyst tries to achieve and those that he should avoid in order to obtain unambiguous and precise results.

The subjects treated in the present volume are the determinations of (i) organic acids, (ii) acid anhydrides, (iii) amines and amides, (iv) olefinic unsaturation; (v) analytic mass spectrometry, and (vi) analytic examination of synthetic coating resins. The monograph on the determination of organic acids is

much more extensive than the chapter on microtitration methods in the second volume of the series.

Each monograph has a selected bibliography; the largest, on olefinic unsaturation, contains 698 references. All the authors covered the literature through 1955, and some 1956 publications are also reviewed. There is a general subject index to the three volumes of the series. There were few typographic errors. The only one I found that might cause confusion was the substitution of *nitrate* for *nitrite* in the first paragraph on page 109, and this was corrected in the procedural directions that followed.

The book should prove valuable, not only to analysts, but to all serious students of organic chemistry.

LYMAN CHALKLEY

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Psychological Research. Benton J. Underwood. Appleton-Century-Crofts, New York, 1957. 298 pp. Illus. \$4.

The title *Psychological Research* will suggest many different things to different readers. If summed, these suggestions would include most of the science of psychology. Any attempt to attack such a subject matter in 292 pages will necessarily involve a large amount of selection and gross summarizing, and it will leave some distinctive marks of the author in the process.

Benton J. Underwood has restricted his coverage to what might be labeled the methodological problems of psychological research. Some indication of the coverage is given by the chapter headings. These, in addition to an "Introduction," are "Analysis of the research situation," "Operational definitions," "Research design I and II," "An overview of explanation in psychology," "Some characteristics of concepts," "The nature of some explanatory attempts," and "Potpourri."

Within the framework outlined by the chapter headings, this book is somewhat author-centered. This characteristic is partially anticipated in the introduction by the statement, "I wish merely to discuss critically some of the problems of research in psychology as I see them." The book is perhaps most tersely described by the word *essay*, for it is a personalized and editorialized account of psychological research. This is shown partly in the style of writing, which has a generous sprinkling of first-person-singular pronouns, autobiographical statements, and brief editorial excursions into such matters as journal publication policy, and so forth. It is also shown by the intermittent insertion of experimental materials that seem to bear little rele-

vance to the outline, while the discussion of some widespread and important problems (stimulus and response definition, scaling, and so forth) falls far short of what is possible at the present stage of psychological development. Since the author's aim is to discuss research topics as he sees them, however, he must be judged as having succeeded. It is probably also true that, in approaching the problem in this way, he has achieved readability and added a human quality to the book.

As the chapter headings suggest, the book addresses itself to many interesting methodological problems—problems that must be attacked by psychologists who have a firsthand familiarity with the concepts, as they work in an experimental program, as well as by philosophers of science who may analyze the formal properties of the concept as these are eventually revealed in articles and secondary sources. As an analysis by an experimental psychologist, the book will broaden the spectrum of material available for the undergraduate and graduate in psychology, while it leaves ample room for a more analytic book, which will present a more specific account of some of the subtleties of these methodological questions and give the psychology student a broader base of information from which he can form his own opinion.

CONRAD G. MUELLER

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Osteology of the Reptiles. Alfred S. Romer. University of Chicago Press, Chicago, 1957. 772 pp. Illus. \$20.

As initially conceived, this book was to be a revision of S. W. Williston's *Osteology of the Reptiles*, which was published in 1925. In the early stages of the project, however, it became evident that a single revision would not do justice to the many advances in reptilian osteology and classification that have been made in the intervening years. The name and the general plan of organization have been retained, but otherwise the book is completely new. Williston's work was prepared by W. K. Gregory on the basis of a partial draft that was left by Williston, on his death in 1918. It is an excellent, but brief, survey of reptilian osteology and classification. The present volume is detailed and comprehensive.

Alfred Romer's *Osteology of the Reptiles* comprises two major sections. The first presents a structure-by-structure analysis of the reptilian skeleton, and the second, a classification based on skeletal characteristics. The section on structure is introduced by a rather brief account of nonskeletal systems and reptilian em-

bryology. A general discussion of the skeleton follows. The succeeding eight chapters give detailed accounts of the subdivisions of the skeleton, with both living and extinct reptiles as source material. The text is accompanied by 166 figures that portray the structures under consideration. The illustrations are excellent in quality and are based, in large part, on data published over the years in a wide range of zoological and paleontological studies. Text and figures complement each other to provide a coherent and comprehensive survey of reptilian osteology.

The second section is introduced by an account of the history of classification of the reptiles. This is followed by a systematic treatment of the subclasses and subordinate taxonomic categories to the level of family, and, in some cases, subfamily. Descriptions and diagnoses for each categorical rank are presented, and, under the familial listings, there is a comprehensive list of genera, with synonyms. It was, of course, impossible to include a study of even a small part of the nomenclatural problems. Even had this been feasible, it would have seriously detracted from the continuity and general usefulness of the book.

The classification is based on a primary division of the class Reptilia into six subclasses, with one order, Mesosauria, unassigned. The orders that are included under the subclasses are recognized as pertaining either to "Sauropsida" (subclass Anapsida, excluding the cotylosaurs, subclass Lepidosauria, subclass Archosauria, and order Mesosauria) or to "Therapsida" (subclass Ichthyopterygia, subclass Euryapsia, and subclass Synapsida), following Goodrich and, more recently, Watson. The classification is relatively conservative throughout, and well-established names are used for the various groups. Specialists in various fields will undoubtedly find arrangements with which they disagree, for there is no general consensus on the placement of many reptilian genera. The descriptions and diagnoses of the categorical levels, however, are brief and factual and show clearly the reasons for assignments. Illustrations in this section consist of figures of complete skeletons of characteristic genera. Since materials for valid reconstructions are not available for many groups, the pictorial representation is inevitably somewhat irregular.

A short bibliography follows the section on classification. It lists only the major sources of information that were used in compilation of the book. These are presented under headings that relate them to the sections to which they are most pertinent. References to more complete bibliographies are given.

This book is a truly monumental contribution that cannot fail to stand as a

landmark in the study of reptiles, both living and extinct, over the years to come. The style is marked by the lucid, almost conversational pattern so familiar to readers of Romer's earlier books and reports. All persons who have an interest in reptilian morphology, classification, and evolution will find the book a stimulating and indispensable reference work. The enduring use that it is certain to have should, to some degree, repay the author for the tremendous labor that went into its preparation.

EVERETT C. OLSON

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University of Chicago

Books Reviewed in

The Scientific Monthly, June

World Symposium on Applied Solar Energy, Proceedings (Association for Applied Solar Energy). Reviewed by M. Telkes.

Aspects of Culture, H. L. Shapiro (Rutgers Univ. Press). Reviewed by F. H. H. Roberts, Jr.

The Great Chain of Life, J. W. Krutch (Houghton Mifflin). Reviewed by H. J. Deason.

An Encyclopaedia of the Iron and Steel Industry, A. K. Osborne, compiler (Philosophical Library).

The Galathea Deep Sea Expedition 1950-1952, A. F. Bruun, S. Greve, H. Mielche, R. Sparck (Macmillan). Reviewed by J. E. Bardach.

Discussions on Child Development. Proceedings of the World Health Organization Study Group on the Psychological Development of the Child: vols. I and II, J. M. Tanner and B. Inhelder, Eds. (International Universities Press). Reviewed by J. E. Anderson.

Advances in Electronics and Electron Physics, vol. VIII, L. Manton, Ed. Reviewed by D. ter Haar.

The Wind and the Weather, J. Bolton (Cromwell). Reviewed by S. S. Visher.

New Books

Vegetable Crops. Homer C. Thompson and William C. Kelly. McGraw-Hill, New York, rev. ed. 5, 1957. 619 pp. \$8.50.

Manual of Radiation Therapy. K. Wilhelm Stenstrom. Revised with additions and discussions by Paul C. Olfelt and Frances Conklin. Thomas, Springfield, Ill.; Blackwell, Oxford, England; Ryerson, Toronto, 1957. 124 pp. \$4.50.

Route-Mapping and Position-Locating in Unexplored Regions. Wilhelm Filchner, Erich Przybyllok, Toni Hagen. Academic Press, New York; Birkhauser, Basel, Switzerland, 1957. 288 pp. \$9.

Biogeography. An ecological perspective. Pierre Dansereau. Ronald, New York, 1957. 407 pp. \$7.50.

The Granite Controversy. Geological addresses illustrating the evolution of a disputant. H. H. Read. Interscience, New York, 1957. 449 pp. \$6.75.

Handbuch der Physik, vol. XLVIII, *Geophysics II*. S. Flüge, Ed. Springer, Berlin, 1957. 1053 pp. DM. 198.

Gmelins Handbuch der Anorganischen Chemie. System No. 28, Calcium, pt. A, sec. 2, *Occurrence, the element, the alloys*. 500 pp. \$55.68. System No. 32, Zinc, suppl. 1061 pp. \$138. System No. 68, Platinum, pt. D, *Complex compounds with neutral ligands*. 692 pp. \$90. Edited by Gmelin Institute under the direction of E. H. E. Pietsch. Verlag Chemie, Weinheim/Bergstrasse, ed. 8, 1957, 1956, 1957.

Critical Notes on Evolution. William L. Fischer. William L. Fischer, Gabelsbergerstrasse 30, Muenchen, Germany, 1957. 111 pp.

Proceedings of the International Wool Textile Research Conference, Australia 1955, vol. D, *Physics of Wool and Other Visco-elastic Fibres*. 272 pp. vol. E, *Wool Technology*, pt. 2. 620 pp. W. G. Crewther, Ed. Commonwealth Scientific and Industrial Research Organization, Australia, Melbourne, 1956.

Village and Plantation Life in Northeastern Brazil. Harry William Hutchinson. An American Ethnological Society publication, cosponsored by the Research and Training Program for the Study of Man in the Tropics. University of Washington Press, Seattle, 1957. 208 pp. \$3.50.

The Concept of Development. An issue in the study of human behavior. Dale B. Harris, Ed. University of Minnesota Press, Minneapolis; Oxford University Press, London, 1957. 297 pp. \$4.75.

The Climate near the Ground. Rudolf Geiger. Translated from German ed. 2 of *Das Klima der Bodennahen Luftschicht*, with revisions and enlargements by the author, by Milroy N. Stewart et al. Harvard University Press, Cambridge, Mass., rev. ed. 2, 1957. 514 pp. \$6.

The Leukemias: Etiology, Pathophysiology, and Treatment. Henry Ford Hospital international symposium. John W. Rebusch, Frank H. Bethell, Raymond W. Monto, Eds. Academic Press, New York, 1957. 719 pp. \$13.

Semiconductors: Their Theory and Practice. G. Goudet and C. Meuleau. Translated from the French by G. King. Macdonald and Evans, London, 1957. 334 pp. 5 guineas.

Earth Flexures. Their geometry and their representation and analysis in geologic section with special reference to the problem of oil finding. H. G. Busk. Trussell, New York, ed. 2, 1957. 112 pp. \$3.95.

Clinical Psychology of Exceptional Children. C. M. Louttit, David H. Crowell, Victor Goertzel, Mildred G. Goertzel, Jack Matthews, Harold F. Powell, Michael M. Reece. Harper, New York, ed. 3, 1957. 585 pp. \$6.

The Miracle of Growth. A. Sundgaard, in collaboration with the Chicago Museum of Science and Industry. Pyramid, New York, ed. 2, 1956. 93 pp. Paper, \$0.35.

Early Electrical Machines. The experiments and apparatus of two inquiring centuries (1600 to 1800) that led to the triumphs of the electric age. Bern Dibner. Burndy Library, Norwalk, Conn., 1957. 57 pp. \$1.50.

Atomic Energy Applications with Reference to Underdeveloped Countries. A preliminary survey. B. C. Netschert and S. H. Schurr. Published for Resources for the Future, Inc., by the Johns Hopkins Press, Baltimore, Md., 1957. 143 pp. \$2.

Miscellaneous Publications

Silicones in Medicine and Surgery. R. R. McGregor. Dow Corning Corp., Midland, Mich., 1957. 44 pp.

Schools for Tomorrow: an Educator's Blueprint. Alexander J. Stoddard. Fund for the Advancement of Education, New York, 1957. 61 pp.

Blueprint for Talent Searching. America's hidden manpower. National Scholarship Service and Fund for Negro Students, New York, 1957. 42 pp. \$0.50.

A New Emphasis on Economic Development Abroad. A report to the President of the United States on ways, means, and reasons for U.S. assistance to international economic development. International Development Advisory Board, Washington, D.C., 1957. 18 pp.

Grain Research Laboratory 1956 Report. J. Ansel Anderson. Board of Grain Commissioners, Winnipeg, Manitoba, Canada, 1957. 80 pp.

A Case History of Communist Penetration: Guatemala. U.S. Department of State publ. 6465; Inter-American ser. 52. Government Printing Office, Washington, D.C., 1957. 73 pp. \$0.30.

Report of the International Commission on Radiological Units and Measurements (ICRU), 1956. National Bureau of Standards handbook 62 (supersedes handbook 47). U.S. Department of Commerce (order from Government Printing Office, Washington 25, D.C.), 1957. 48 pp. \$0.40.

Research on the Refrigeration of Perishable Commodities. Annual rept. Refrigeration Research Foundation, Colorado Springs, Colo., 1956. 39 pp.

A Guide to Molluscan Anatomy for Parasitologists in Africa. C. A. Wright. British Museum (Natural History), London, 1957. 20 pp. 1s. 6d.

Guia de Campo del Investigador Social. Manuales tecnicos III. pt. 1, Antropologia social. Union Panamericana, Washington, D.C., 1956. 101 pp.

Mesenchymal Diseases in Childhood. Report of the 22nd Ross Pediatric Research Conference. Ross Laboratories, Columbus, Ohio, 1957. 103 pp.

Bibliography of Scientific Publications of South and South East Asia, vol. 2, No. 4. Compiled by UNESCO Science Cooperation Offices for South and South East Asia. Insdoc, National Physical Laboratory, New Delhi, 1957. 53 pp.

What Are the Facts about Mental Illness in the United States? National Committee against Mental Illness, Washington, D.C., 1957. 44 pp.

Meetings and Societies

Clinical Drug Evaluation

A working conference, the first of a series of programs sponsored by the Psychopharmacology Service Center of the National Institute of Mental Health, was held, 14-15 Jan., at the Hotel Woodner, Washington, D.C. The major purpose of the conference, arranged in collaboration with the American Psychiatric Association, was to review the problems involved in the reporting of psychiatric drug evaluation studies and to consider means for making such reports more informative and useful.

Several specific needs and conditions in the area of psychopharmacology led to the conference, which was attended by approximately 42 psychiatrists who are actively engaged in evaluating the effects of drugs in hospitals and in other settings throughout the country. Other participants were psychologists, internists, pharmacologists, and those in related fields.

Among the background conditions for the conference were (i) the great and expanding mass of clinical literature on drug evaluation; (ii) inadequacies in the published papers, particularly with regard to the details of the study; (iii) present pressures, and the effects of anticipated pressures, for space in the technical journals that represent the area of psychopharmacology; and (iv) the need for rapid presentation and exchange of information for optimal development of techniques and utilization of research findings.

To set down the details of methodological standardization did not come within the planning or scope of the conference. The mission was to improve the communication processes with regard to the published literature. The purpose of the conference was not merely to develop recommendations on ways of providing more information but to determine what kinds of information would make reports more meaningful, relevant, and generally conducive to improved research efforts.

The executive committee for the conference was as follows: Jonathan O. Cole (chairman), Nathan S. Kline (vice chairman, representing the American Psychiatric Association), Sherman Ross

(executive secretary), Ralph W. Gerard, and Philip Sapir. In addition to clinical psychiatrists, psychologists, and other experts, a group of editors was invited, to examine the impact on their journals of research in psychopharmacology and to consider the implications on the scientific and medical literature of the present major effort.

Each participant served as a member of one of five committees: (i) Patient Selection and Description (Harry Freeman, chairman), (ii) Evaluation of Change (Ivan F. Bennett, chairman), (iii) Description of the Treatment Setting (Jay L. Hoffman, chairman), (iv) Drug Therapy and Toxicity Reactions (Heinz Lehmann, chairman), and (v) Editors (Roy Grinker, chairman).

The recommendations that resulted from the efforts of each of these committees include more than 100 items of information believed to be of significance in any report of a drug evaluation. Although the conference was not concerned with design or planning of investigations, it is clear that if such information is necessary or desirable in the reports, then the research investigation must be designed to provide it.

A full report of the conference recommendations is now being prepared for publication. When the report appears, copies may be secured by writing to the Psychopharmacology Service Center, National Institute of Mental Health, Bethesda 14, Md. Additional work conferences on topics of importance to clinicians and scientists who are working in the area of psychopharmacology are also being planned.

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SHERMAN ROSS

LORRAINE BOUTHILET

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Cooper Ornithological Society

Among the new affiliates of the American Association for the Advancement of Science is the Cooper Ornithological Society, which was organized in 1893 and now has members in all states and territories of the United States and in Canada, Mexico, and 34 other coun-

tries. There are two divisions of the society, each of which meets once a month in California. The northern division meets in Berkeley, and the southern division meets in Los Angeles. An annual meeting is held in the spring for the presentation of papers.

The society was incorporated in June 1934, and the corporate powers are invested in a board of directors. A board of governors is the policy-making body of the society. It is composed of the past and present officers of the two divisions of the society. Officers and members of the board of directors and officers of the board of governors are elected at the annual meeting.

Cooper Ornithological Society is strong financially and has a large endowment fund. This makes possible the publication of a large bimonthly journal, *The Condor*, and a series of publications entitled *Pacific Coast Avifaunas*. *The Condor*, now in its 59th year, publishes papers on many phases of avian biology. These papers deal with birds in all parts of the world and are usually illustrated, often with color plates.

The *Pacific Coast Avifaunas* series was started in 1900 with *The Birds of the Kotzebue Sound Region, Alaska*, by Joseph Grinnell; it now includes 31 publications, the most recent one (1954) being *Life Histories of Central American Birds*, by Alexander F. Skutch. Three new *Avifaunas* are scheduled for publication in 1957.

Alden H. Miller, Museum of Vertebrate Zoology, University of California, Berkeley, is editor of both the journal and the publications series. The associate editor is Frank A. Pitelka, and the assistant editor is John Davis. Requests for information concerning membership and subscriptions should be addressed to C. V. Duff, business manager, 2911 Antelo View Drive, Los Angeles 24; information concerning past issues of the journal and the publications series may be obtained from T. R. Howell, department of zoology, University of California, Los Angeles 24.

C. V. DUFF

Los Angeles, California

Calorimetry Conference

The 12th Calorimetry Conference will be held at the Wentworth-By-The-Sea, near Portsmouth, N.H., 3-6 Sept. On 7 Sept. there will be a visit to Arthur D. Little, Inc., Cambridge, Mass., to see cryogenic equipment; there will be an opportunity to visit calorimetric laboratories in the Boston area.

Contributed papers will be presented at morning sessions and there will be sessions on special topics in the evening with invited speakers. The afternoons will be

free for informal discussion and recreation. Henry A. Boorse of the Pupin Physics Laboratory, Columbia University, is chairman of the conference. Prof. Donald H. Andrews, Chemistry Department, Johns Hopkins University, Baltimore 18, Md. is program chairman, and is in charge of arrangements with Prof. Charles E. Messer, Chemistry Department, Tufts University, Medford 55, Mass.

European Cytology Symposium

The Committee on Cancer Control of the International Union Against Cancer is sponsoring a European Symposium on Applied Cytology that is scheduled to take place in Brussels, Belgium, 11-13 July, the week prior to the International Congress of Clinical Pathology, which will also take place in Brussels. Although this meeting is held primarily for European pathologists and clinicians, members of any specialty of the medical profession and medical students are invited to attend and participate in the discussions. Honorary chairman of the meeting is George N. Papanicolaou, professor of anatomy at Cornell University Medical College.

Further details may be obtained from Dr. Brewster S. Miller, Secretary, Committee on International Congresses, American Cancer Society Inc., 521 W. 57 St., New York 19, N.Y.

Homeostatic Mechanisms

The tenth annual summer conference sponsored by the biology department of Brookhaven National Laboratory will be held 12-14 June. The subject of this symposium is "Homeostatic mechanisms," particularly those which regulate the blood and the blood-forming elements. The conference will be held at the laboratory, which is located at Upton, Long Island, about 65 miles from New York. Inquiries about further information should be addressed to Dr. H. J. Curtis of the Biology Department.

Viral and Rickettsial Symposium

The University of Wisconsin School of Medicine has announced a symposium on Latency and Masking in Viral and Rickettsial Infections that is to be held on the university campus, 4-6 Sept. The purpose of the symposium is to consider recent information in human, animal, and plant systems that bear on the interaction between host cell, infecting agent, and the cellular environment.

The program is divided into three general discussion areas after a keynote ad-

dress by C. H. Andrewes of London, England. The first day will be devoted to "Viral characteristics leading to masking and latency," the second to "Factors of host cell and environment to masking and latency," and the third to "The role of inhibitors in masking and latency." A final summary and critique is scheduled for the final afternoon to discuss common terminology and the present concepts of mechanism.

Participants include C. H. Andrewes and F. C. Bawden from England, A. Lwoff from France, G. H. Berghold from Canada, and the following from the United States: J. W. Beard, R. Dulbecco, F. Duran-Reynals, T. Puck, C. B. Philip, H. R. Morgan, H. B. Andervont, W. R. Bryan, H. S. Ginsberg, and W. W. Ackermann.

Accommodations in university dormitories are available for about 300 guests and participants at \$20 for the 3-day period, payable at time of registration. Reservations should be addressed to Dr. A. S. Evans, Division of Preventive Medicine, University of Wisconsin Medical School, Madison, Wis.

Society Elections

■ Society of Animal Production: pres., J. C. Miller, Texas Agricultural and Mechanical College; v. pres., W. M. Beeson, Purdue University; North Atlantic v. pres., George V. Noot, Rutgers University; Southern v. pres., W. P. Garrigus, University of Kentucky; Western v. pres., N. W. Hilston, University of Wyoming; sec., H. H. Stonaker, Colorado State University. Representative to the AAAS Council is Ted C. Byerly.

■ Arkansas Academy of Science: pres., J. R. Mundie, Ouachita Baptist College; pres.-elect, C. E. Hoffman, University of Arkansas; sec.-treas., Lowell F. Bailey, University of Arkansas. Representative to the AAAS Council is Dwight M. Moore.

■ AAAS Southwestern and Rocky Mountain Division: pres., Morris F. Stubbs, New Mexico Institute of Mining and Technology; v. pres., Albert R. Mead, University of Arizona; exec. sec.-treas., Marlowe G. Anderson, New Mexico Agricultural and Mechanical College.

■ Aero Medical Association: pres., Ashton Graybiel; past pres., Jan H. Tillisch; pres.-elect, M. S. White; sec.-treas., Thomas H. Sutherland, Marion, Ohio. The 1st v. pres. is Ludwig G. Lederer and other vice presidents are Brock R. Brown, Ottawa, Can.; R. Grandpierre, Paris, France; Pelagio G. Potenciano, Manila, P.I.; and John P. Stapp, Holoman Air Force Base, N.M.

■ Alabama Academy of Science, Inc.: pres., Howard Carr, Alabama Polytechnic Institute; sec., Hoyt Kaylor, Department of Physics, Birmingham-Southern College. Representative to the AAAS Council is Patrick Yancey.

■ Minnesota Academy of Science: pres., Harold T. Peters, Bemidji State College; v. pres., Frank Verbrugge, University of Minnesota; sec.-treas., Blanchard O. Krogstad, University of Minnesota.

■ North Carolina Academy of Science: pres., E. W. Berry, Duke University; v. pres., Victor A. Greulich, University of North Carolina; sec.-treas. and representative to AAAS council, John A. Yarbrough, Meredith College.

Forthcoming Events

June

25-27. Max Planck Soc. for the Advancement of Science, annual general assembly, Lübeck, Germany. (Max Planck Soc. for the Advancement of Science, Kaiserwertherstrasse 164, Dusseldorf, Germany.)

25-28. American Dairy Science Assoc., 51st annual, Stillwater, Okla. (H. F. Judkins, 32 Ridgeway Circle, White Plains, N.Y.)

25-28. American Home Economics Assoc., St. Louis, Mo. (Miss M. Horton, AHEA, 1600 20 St., NW, Washington 9.)

30-1. National Education Assoc., annual, Philadelphia, Pa. (W. G. Carr, NEA, 1201 16 St., NW, Washington 6.)

July

1-3. Reproduction and Infertility, 3rd symp., Fort Collins, Colo. (F. X. Gassner, Colorado State Univ., Fort Collins.)

1-6. Brazilian Soc. for the Advancement of Science, 9th annual, Rio de Janeiro, Brazil. (Sociedade Brasileira Para o Progresso da Ciencia, Caixa Postal 2926, São Paulo, Brazil.)

1-6. Industrial Medicine, 12th internatl. cong., Helsinki, Finland. (L. Noro, Inst. of Occupational Health, Huopalahdenkatu 1, T8818, Helsinki.)

2-4. Neurological Basis of Behavior, Ciba Foundation Symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1.)

2-6. Physical Problems of Color Television, internatl. symp. of IUPAP, Paris, France. (Secretary, Colloque International sur les Problèmes de la Télévision en Couleurs, Conservatoire National des Arts et Métiers, 292, rue Saint-Martin, Paris 3^e.)

3-6. Current Problems in Crystal Physics, conf. IUPAP and NSF, Cambridge, Mass. (J. S. Slater, Massachusetts Inst. of Technology, Cambridge 39.)

8-10. Astrophysical Symp., 8th internatl., Liège, Belgium. (P. Swings, Institut d'Astrophysique, Université de Liège, Liège.)

8-10. Endocrine Aspect of Breast Can-

cer, Internatl. conf., Glasgow, Scotland. (A. P. M. Forrest, Dept. of Surgery, Western Infirmary, Glasgow, W.1.)

8-12. Inter-American Cong. of Philosophy, 5th, Washington, D.C. (R. M. Chisholm, Brown Univ., Providence, R.I.)

8-12. Poliomyelitis Conf., 4th internatl., Geneva, Switzerland. (Secretariat, 4th International Poliomyelitis Conference, Hotel du Rhone, Geneva.)

9-11. Biological Symp., 8th annual, Univ. of Michigan, Ann Arbor. (B. L. Baker, Dept. of Anatomy, Univ. of Michigan, Ann Arbor.)

9-13. European Molecular Spectroscopy Conf., Freiburg, Breisgau, Germany. (R. Mecke, Dept. of Physical Chemistry, Univ. of Freiburg, Freiburg.)

9-13. International Cong. for the Study

of Social Insects, Paris, France. (G. Richard, International Union for the Study of Social Insects, Faculty of Sciences, University of Rennes, Rennes, France.)

10-12. Thermodynamic and Transport Properties of Fluids, conf., IUPAC, London, England. (Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W. 1.)

10-17. International Union of Crystallography, 4th genl. assembly, Montreal, Canada. (G. A. Jeffrey, Chemistry Dept., Univ. of Pittsburgh, Pittsburgh 13, Pa.)

11-13. Applied Cytology, European Symp., Brussels, Belgium. (Secretary, Comm. on International Cong., American Cancer Soc., 521 W. 57 St., New York 19, N.Y.)

14-19. International Assoc. of Gerontology, Merano, Italy. (A. I. Lansing, Dept. of Anatomy, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

14-20. Clinical Pathology, 4th internatl. cong., Brussels, Belgium. (M. Welsh, Service de Bacteriologie et de Parasitologie, Université de Liège, Blvd. de la Constitution, Liège, Belgium.)

15-18. Biochemistry of Lipids, International Colloquium, Oxford, England. (Dr. Sinclair, Laboratory of Human Nutrition, Oxford.)

15-19. Institute on College Administration, annual, Ann Arbor, Mich. (A. D. Henderson, 2442 U.E.S., Univ. of Michigan, Ann Arbor.)

16-19. American Malacological Union, annual, New Haven, Conn. (Miss M. C. Teskey, P.O. Box 238, Marinette, Wis.)

16-24. International Cong. for Pure and Applied Chemistry, 16th, Paris, France. (R. Morf, Secy. Genl., IUPAC, Sandoz, S.A., Basel, Switzerland.)

20-21. Medical-Sociological Aspects of Senile Nervous Diseases, internatl. symp., Venice, Italy. (S. N. Feingold, Jewish Vocational Service of Greater Boston, 70 Franklin St., Boston 10, Mass.)

21-28. Neurological Sciences, 1st internatl. cong., Brussels, Belgium. (P. Bailey, National Institutes of Health, Bethesda 14, Md.)

23-24. Modern Electrochemical Methods of Analysis, Internatl. symp., Paris, France. (G. Charles, Ecole Supérieure de Physique et de Chimie, 10, rue Vauquelin, Paris 5e.)

25-26. Structure Properties Relationships of Polymers (IUPAC), Paris, France. (International Union of Pure and Applied Chemistry, 4, Avenue de l'Observatoire, Paris 6e.)

25-29. Protein Chemistry Symp., IUPAC, Paris, France. (J. Roche, Collège de France, Place Marcellin Berthelot, Paris 5e.)

26-27. Experimental Psychology and Animal Behavior Section of International Union of Biology, Brussels, Belgium. (H. S. Langfeld, Dept. of Psychology, Princeton Univ., Princeton, N.J.)

26-27. Linguistic Soc. of America, Ann Arbor, Mich. (A. A. Hill, Box 7790, University Station, Austin 12, Tex.)

26-27. Military Psychology, internatl. symp., Brussels, Belgium. (National Academy of Sciences, 2101 Constitution Ave., NW, Washington 25.)

26-1. International Congress on Nutrition, 4th, Paris, France. (Quatrième Congrès International de Nutrition, CNERNA, 71, boulevard Péreire, Paris 17e.)

28-1. Psychoanalysis, 20th internatl. cong., Paris, France. (Dr. Nacht, 187, rue Saint-Jacques, Paris 5.)

28-3. Psychology, 15th internatl. cong., Brussels, Belgium. (L. Delys, 296, avenue des Sept Bonniers, Forest-Brunelles.)

31-5. International Assoc. for Hydraulical Research, Lisbon, Portugal. (M. Coelho Mendes da Rocha, Laboratorio Nacional de Engenharia Civil, Avenida do Brasil, Lisbon.)

31-6. Dermatology, 11th internatl. cong., Stockholm, Sweden. (C. H. Floden, Hudkliniken, Karolinska Sjukhuset, Stockholm 60.)

(See issue of 17 May for comprehensive list)

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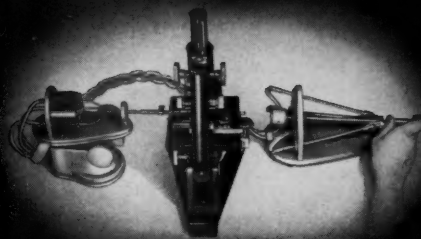
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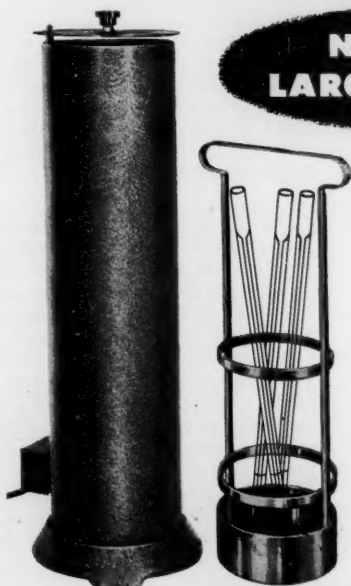
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■ **FILTRATION UNITS** for removal of minute particles from water have capacities ranging from 3 to 10 gal/min. The fineness of particle removal ranges from 0.1 to 25 μ . (Heico Inc., Dept. S354)

■ **SWEEPING OSCILLATOR** covers the range of frequencies from 1000 to 15,000 Mcy/sec with a power output of from 10 mw to 1 w by means of seven interchangeable units. Used in conjunction with the man-

ufacturer's rapid-scan Ratioscope, the oscillator makes possible direct and instantaneous measurements of reflection and transmission coefficients, directly viewable on an oscilloscope, eliminating the need for point-by-point measurements or for maintaining a constant power input to the device under test. (Polarad Electronics Corp., Dept. S351)

■ **MAGNET WIRE** coated with Teflon is being offered in a kit for research and development use. The kit contains an assortment of 12 spools of wire in gage sizes 20 through 42 A.W.G. (Tensolite Specialties Inc., Dept. S365)

■ **MAGNETIC-TAPE HANDLER** consists of ten separate identical units or bins, each with a capacity of over 8×10^6 bits. Each bin normally contains 500 ft of 1-in. wide magnetic tape for 14-channel recording with 200 pulse/in. density. Each bin is

equipped with its own record-playback head which may be switched by relay to a common output. Dual speeds of 30 or 60 in./sec or other combinations are provided. (Potter Instrument Co., Inc., Dept. S362)

■ **SILICON** of semiconductor grade is commercially available. Three grades, research, premium, and standard, will be marketed. The research grade has a resistivity greater than 200 ohm cm and impurity content less than 1 part in 10^9 . Minimum resistivity of the premium grade is 100 ohm cm and of the standard grade 10 ohm cm. (Texas Instruments, Inc., Dept. S356)

■ **GEM-TESTING SET** is based on the fact that neither index of refraction nor specific gravity separately will identify a gem but that together these properties will identify a gem with certainty. The set includes a "Refractoscope" used with six index-of-refraction liquids and a set of nine specific-gravity liquids. (R. P. Cargille Laboratories, Inc., Dept. S357)

■ **FREEZE DRYING UNIT** handles 300 5-ml serum bottles simultaneously. The trays upon which samples are placed revolve once each minute in front of a radiant-heating source to heat all samples uniformly. A tilting-type McLeod gage furnishes vacuum measurement. Dimensions of the unit are 12.5 by 23.5 by 15.5 in. (E. Machlett and Son, Dept. S358)

■ **STAINLESS STEEL FLASKS**, insulated with light-weight, rigid, closed-cell plastic, are said to provide insulating properties superior to vacuum flasks. The steel flasks, of wide-mouth design, are available in 2-, 4- and 8-lit capacities. (E. Machlett and Son, Dept. S360)

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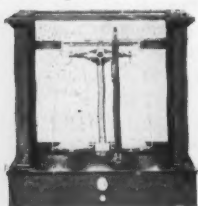
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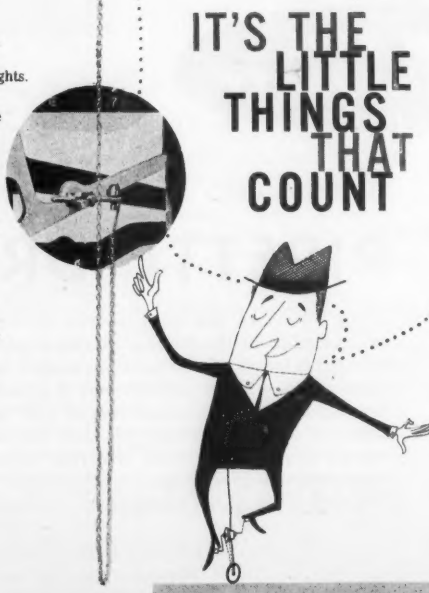
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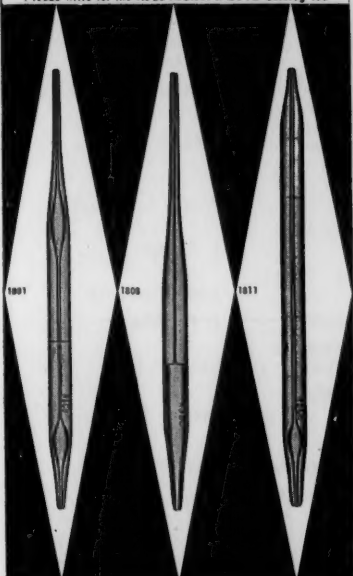


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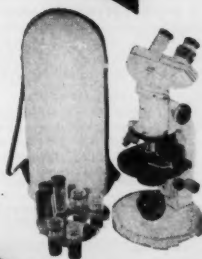
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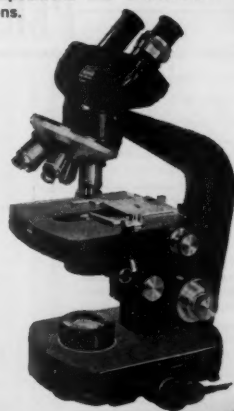
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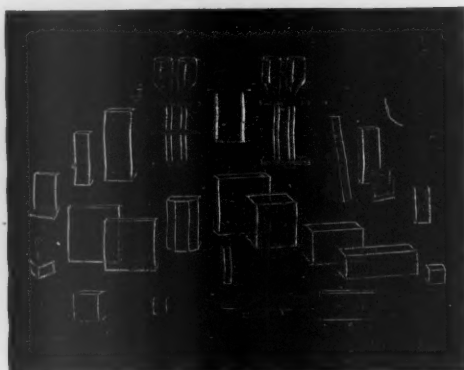


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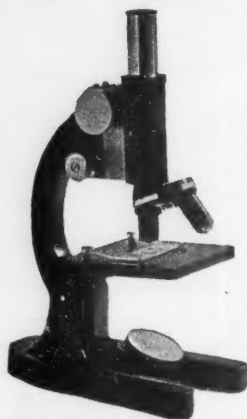
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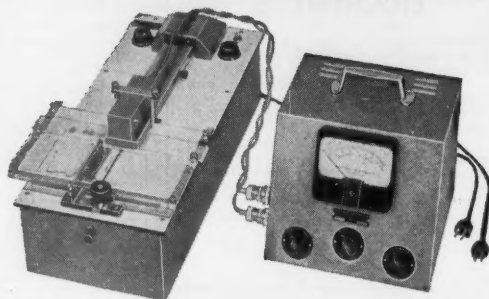
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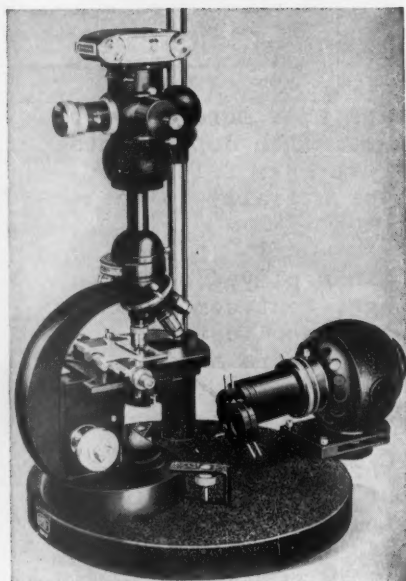
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